

**Evaluating a Regional Support Network for
Technology-based Entrepreneurship: The Case of
Connect Scotland**

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DECLARATION

I declare that the thesis has been composed by myself with the work my own and that this work has not been submitted for any other degree or professional qualification.

Geoff Gregson

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ABSTRACT

This thesis examines a regional enterprise support network in the UK – Connect Scotland. There are several conceptual and theoretical gaps regarding the creation, evolution and effectiveness of formal support networks to stimulate technology-based entrepreneurship and new enterprise creation. One is the need to establish more clearly when and why such networks really matter in the exploitation and commercialisation of technology-based opportunities. This clarification is made difficult by the evolving nature of networks over time and lack of definition of units of analysis – e.g. network, region, enterprise, entrepreneur and knowledge creator. Few studies have examined how regional support networks have helped create ‘successful’ technology regions similar to Silicon Valley by informing practice and policy decisions. Finally, it is not clearly understood what the roles and activities of various public and private agents are and how they enable or constrain technology-based innovation exploitation and enterprise creation in a regional context. A study of a regional enterprise support network - Connect Scotland – during its formative years (1997-2002) provided the research case. A methodology was developed from process evaluation guidelines, Molina’s socio-technical constituency model and Van de Ven’s social system framework in order to evaluate a regional support network over time. The methodology used the network and its primary stakeholders - private sponsors, universities and technology companies - as units of analysis to examine the evolution of network support processes and effects on *all* active stakeholders of the network - rather than simply new enterprises. Empirical research included assessment of network event and participation data over 5 years (1997-2001); two value surveys, in 1999 and 2001 of 116 stakeholders; 6 cases studies of early-stage technology companies, interviews with over 50 stakeholders between 1999 and 2002 and examination of 5 other regional mechanisms that influence Connect’s impact and effectiveness. In summary, over half of the Connect network was assessed. Findings showed key factors in building a national network including strong evidence of intervention need, early support from key private and public sector leaders, identification of clear benefits for stakeholders and a formal, integrated set of recurrent events with targets to ensure event quality and stakeholder mix. High levels of sponsorship renewal were found to result from a combination of altruistic support for Scottish technology and specific benefits being realised through network participation while retention of young technology companies in the network was more affected by sectoral and market conditions. Perceived social, knowledge, and financial value derived by stakeholders was found to evolve between 1999 and 2001 and supported literature that knowledge and financial value becomes more important as social interactions develop among active network participants. Intangible social and knowledge benefits are more immediately realised by Connect stakeholders, whilst tangible investment benefits are traced to those enterprises with clearly superior technologies that are allowed to present at Connect’s investment events. Case studies indicated that Connect’s benefits to these companies are most pronounced in their formative years. Findings indicate that Connect’s 2001 transition to a private company and new network management model challenges facilitation of extensive intangible multi-stakeholder benefits regionally and university-industry stakeholder exchange as more tangible benefits to private sponsors and to ‘high-potential’ technology enterprises take precedence.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

In recent years, entrepreneurship has emerged as a key driver for invigorating business, regions and countries facing the transformation of the world economy and is acknowledged as a fundamental factor in the exploitation of technological innovations and creation of new enterprises.

The desire to stimulate entrepreneurship has lead to a myriad of programs and policies from awareness and education to active market intervention. Market intervention, it is argued, is required to stimulate the identification and interaction of supportive agents that assist in creating a critical mass of competitive enterprises that can make an impact on the regional economy. Initiatives to stimulate industrial clusters, business incubators and science parks are among the public policy tools used, often in partnership with industry, to create supportive conditions for technology-based enterprises.

One conspicuous area of endeavour has been that of *regional enterprise support networks*. Creating regional conditions in support of new enterprises draws on a large body of research showing that the spread of innovations and commercial success is a function of the support that innovators and entrepreneurs can draw from the larger community as well as industry conditions (Pfeffer and Salancik 1977; Vaughn 1983; Ruttan and Hayami 1984; Saxenian 1994; Van de Ven 1993; Porter 1990, 1998).

The extensive literature on agglomeration economies, national and regional systems of innovation and studies of technology clusters and regional innovative milieu also provide the relevant context at this 'regional networks' level (Lundvall 1994; Cooke 1996). Research on entrepreneurial networks identifies the importance of personal and business networks to the entrepreneur in accessing resources, knowledge and

other capabilities and gaining legitimacy for the new company (Birley and Stockley 2000; Johannisson 2000).

Although support networks are an increasingly common intervention strategy, the application of an extensive literature on network theory to the study of regional support networks is underdeveloped. Literature suggests further research on how support networks are created, where and how networks provide value and how networks evolve and change. Further studies are suggested on the management dimension and 'intermediation' of networks and how formal networking activities develop and change over time.

Limited research has examined the commercialisation processes and related difficulties faced by new technology companies and compared these with original intervention objectives and actual network effects. One question is whether company benefits deriving from a formal network-based program are similar to benefits from informal networks identified in the research.

Few studies have looked at networks among other intervention initiatives attempting to develop a region's technology-based commercial and entrepreneurial capabilities. Although literature suggests difficulties in isolating attribution effects of support activity, poorly understood is how beneficiaries as well as initiative managers perceive the value and delivery of multiple intervention initiatives operating within a region.

Research on networks is challenged by the primary social or informal nature of networks and difficulties in tracking how local supportive mechanisms allow new companies to assemble resources and capabilities (Johannisson 2000). Another challenge is the need for a longer evaluation time frame to identify network effects on enterprises (Segal *et al* 1990; North and Smallbone 1996). Methodological difficulties for evaluating intervention programs in general include attribution of cause with effect, lack of available primary data and monitoring of results, program effectiveness and 'success', value for money and cost-benefits and accommodation

of program changes (Patton 1990; Gregory and Martin 1996; Lalkaka and Abetti 1998).

The focus of this thesis is to examine and evaluate a regional support network to stimulate technology entrepreneurship and to support the formation of new technology-based companies in the United Kingdom – *Connect Scotland*. Justification for choosing Connect Scotland as a research case is its applicability to explore many of the evaluation issues just described and the need for Connect to demonstrate to external bodies its relevance and impact. Although anecdotal evidence suggests that Connect is making a difference in supporting technology-based entrepreneurship since it began operations in 1997, this has not been established empirically.

Informing practice on regional support networks is highly appropriate and applicable in the case of Scotland, a country with a strong science and technology base but identified low levels of entrepreneurship and enterprise creation. A further research justification is the opportunity to study an evolving network program and the influences of a changing regional policy and market environment from a participant observation perspective.

1.2 RESEARCH PROBLEM

Three sets of research questions are proposed from the above background. The first set of questions is focused on network theory and practice as it relates to regional support networks. What is a regional support network, how is it created (Grandori and Soda 1995) and what are its management and operational characteristics (Gibb and Davies 1991; Casson 1997)? How do networks make a difference (Chu 1996; Rangan 2000), more specifically – what benefits do a regional enterprise support network provide to network participants and to what extent? How does this network change over time as suggested by evolutionary network theories (Butler and Hanson 1991; Larson and Starr 1993; Gulati *et al* 2000)?

The second set of research questions relates to network effects on new technology companies – the primary targeted beneficiary of most intervention initiatives and for Connect Scotland. What specific commercialisation difficulties are faced by new technology companies that justifies the need for support and what benefits are attributed to involvement within the network? Are benefits of a network-based support initiative similar to network benefits identified in other studies, e.g. social capital effects, knowledge transfer, business credibility, access to resources not held internally, etc (Dubini and Aldrich 1991; Johannisson 2000).

The third set of research questions is focused on the role of the Connect network among other regional support initiatives. What is the role of Connect with universities, seed funding schemes and other initiatives and how are these complementary elements perceived by network stakeholders and used by technology companies? How does the Connect network function as an element of a regional or national system of innovation (Malecki 1997, Freeman 1995, Nelson 1993, Lundvall 1992, 1994; Rosenberg 2002)?

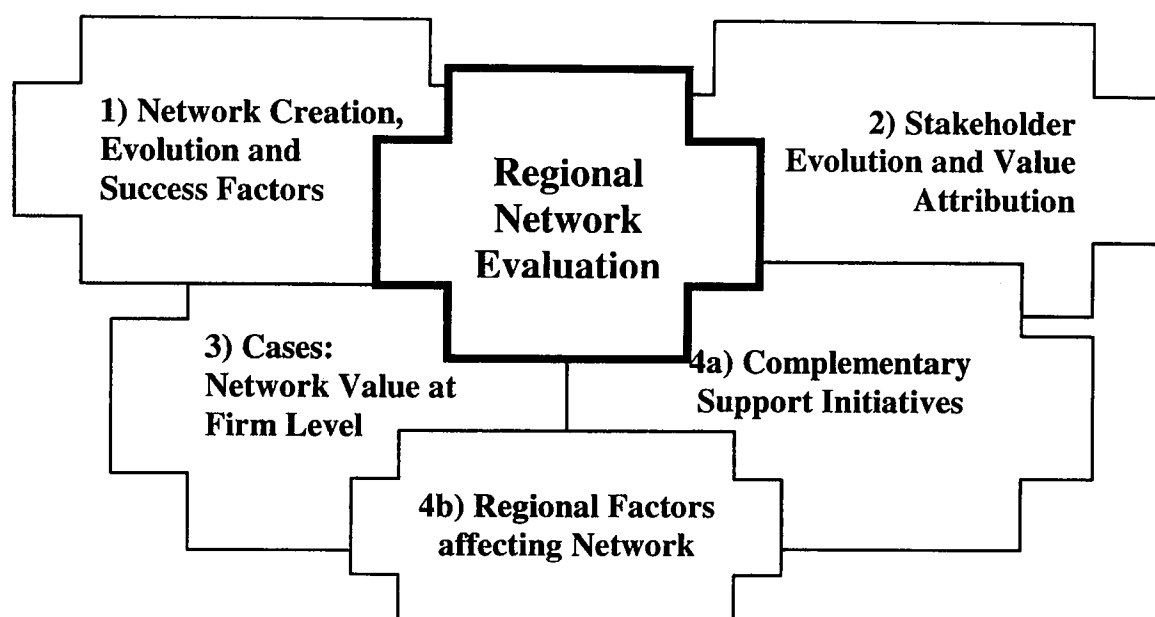
In addition to the three levels of research identified above, practical insights regarding support networks and the Connect program are expected to emerge as research results unfold.

1.3 RESEARCH METHODOLOGY

The research takes Connect Scotland as the focus of inquiry, incorporating an action research design identified as most appropriate when studying change, when the researcher is a participant in the change process and when an intervention technique is being evaluated (Foote Whyte 1991; McKernan 1991). An explicit objective for the research is to develop a ‘practical methodology’ that feeds evaluation insights back to Connect on an ongoing basis. In so doing, the evaluation acts as a ‘learning factor’, contributing to the development of the Connect program by making explicit achievements, difficulties, challenges and weaknesses, with the results fed back into the evolving Connect constituency.

The research incorporates complementary units of analysis to address the three sets of research questions, as Figure 1.1 shows: 1) the network; 2) its stakeholders; 3) the primary intended beneficiary of network efforts, technology companies; 4a) complementary support initiatives; and 4b) external factors affecting the network and support for technology entrepreneurship.

Figure 1.1: Integrated Levels of Analysis: An Action Research Approach to Evaluating Connect Scotland



Network analysis examines the origins and development of the Connect program and describes its events, activities and management mechanisms, the evolution of the network and consequent effects and benefits. Empirical data includes network membership and event attendance data (1997-2001) and interviews with Connect management, board and stakeholders (1999-2002).

Stakeholder analysis examines stakeholder engagement in the network and the evaluation of social, knowledge and financial value benefits identified as explicit objectives of network activities. A total of 20 indicators were chosen for the three value dimensions, with each indicator rated using a Lickert scale. The objective of the survey is to evaluate where Connect has been beneficial to all stakeholders, not simply technology companies, regarding social and business contacts, gaining or giving relevant knowledge, and attracting or providing financing for member companies. A further intention of the value survey is to assess whether or not this

value is changing over time. Empirical data includes stakeholder membership data (1997-2001) two value surveys from 116 stakeholders, 52 stakeholder interviews (1999-2002) and an investment survey from 35 presenting companies (1997-2001).

Case study analysis examines six company members of Connect chosen from a cross-section of technology sectors to capture evidence of commercialisation challenges, actual effects of the Connect program on early-stage formation processes and provide some cross-industry validation of network effects.

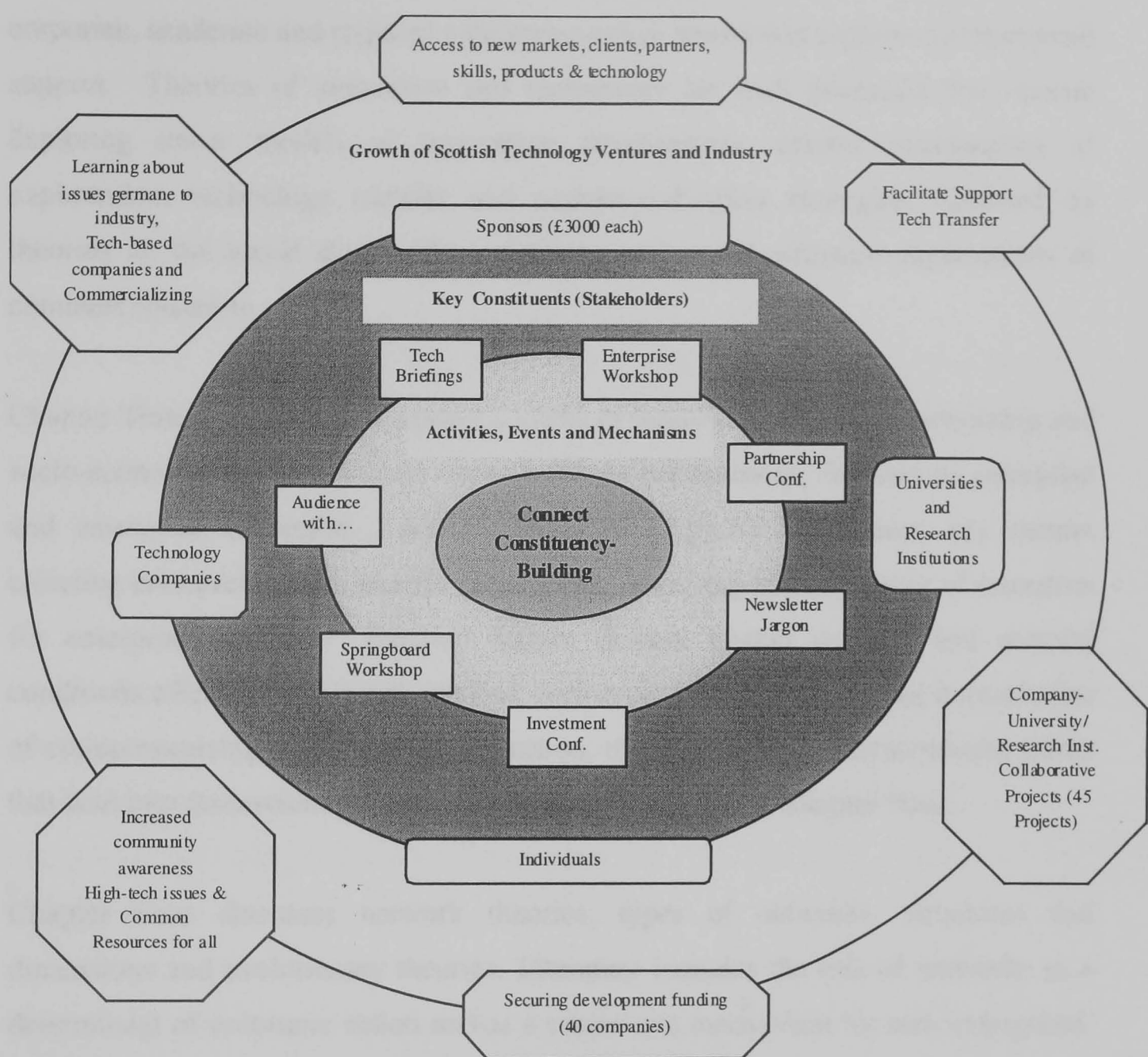
The final level of analysis examines other complementary support initiatives and regional factors that affect Connect's role in supporting technology entrepreneurship and effects on stakeholders. Empirical research examines survey feedback, case studies and interviews with directors of identified complementary initiatives.

The development of Connect is seen as a process of constituency-building targeted on specific stakeholders and intent on achieving defined targets through the implementation of an integrated set of mechanisms and activities. Integrating the above levels of analysis is a '*constituency building model*' or 'conceptual lens', developed to accommodate the development, value, weaknesses and potential for improvement in the Connect constituency-building process (Figure 1.2).

In Figure 1.2, the centre represents Connect as the unit of analysis, namely, the entire process of Connect constituency-building for the purpose of supporting the creation, development and growth of technology-based enterprise throughout Scotland. The first layer around the core shows the main activities, events and mechanisms through which the Connect constituency-process is realised.

The second layer around the core shows the key constituents or stakeholders, either present or targeted by the activities, events and mechanisms of the Connect programmes. The third and final layer around the core shows the target results expected to lead to the ultimate mission of growth of Scottish technology ventures and industry.

Figure 1.2: Network ‘Constituency-Building’ Process



1.4 THESIS OUTLINE

The thesis is divided into two parts that firstly discusses background literature (Chapters Two to Six) and then presents the research undertaken (Chapters Seven to Twelve). Chapter Thirteen concludes the thesis and discusses its various contributions.

1.4.1 Literature Review

Chapter Two introduces key concepts for this thesis that include perspectives on corporate, academic and regional entrepreneurship, innovation regions and enterprise support. Theories of innovation and technology are then discussed that include exploring linear models of innovation development, market explanations of exploitation, technology transfer and commercialisation strategies, followed by theories on the social shaping of technology and social structure explanations of commercialisation.

Chapter Three discusses Schumpeter's views of innovation and entrepreneurship and socio-economic perspectives on the role of the entrepreneur, theories of enterprise and enterprise formation. A multi-theoretical approach discusses key factors affecting entrepreneurship and the configuring, attracting and managing of resources for enterprise creation. External factors discuss market demand and sectoral conditions affecting enterprise survival, formation and growth. Social explanations of entrepreneurship discuss collective action, risk-sharing and entrepreneurial teams that lead into discussions of social and business networks in Chapter Four.

Chapter Four discusses network theories, types of networks, structures and dimensions and evolutionary theories. Literature includes the role of networks as a determinant of economic action and as a supportive mechanism for new enterprises. Perspectives of network management and network evolution discuss the intermediation of social relations and resource exchange and how network benefits and the relevance of networks to entrepreneurs change over time.

Chapter Five discusses the specific characteristics and challenges of technology-based enterprises and markets that distinguish them from more conventional enterprises and markets discussed in Chapter Three. The chapter discusses support structures, institutional linkages and engagement processes that include national and regional systems of innovation, clusters, knowledge spill-overs and transfer, networks and their relevance to technology entrepreneurship.

Chapter Six discusses market intervention mechanisms for stimulating entrepreneurship, justification for intervention in Scotland and the various intervention mechanisms in practice there. The chapter then examines support networks as an intervention mechanism and evaluation recommendations and challenges.

1.4.2 Empirical Research

Chapter Seven discusses research objectives, approach and methods undertaken in this thesis. It builds an argument to justify the research design and development of a constituency-building model and describes the initial pilot study of Connect Scotland that fine-tunes the research approach. The chapter then describes the design framework and empirical data collection activities.

Chapter Eight discusses factors affecting the creation, formation and growth of the network, factors affecting stakeholder engagement and retention in the network and levels of social, knowledge and financial value flows among sponsors, universities and technology companies and recommendations for improving network benefit delivery.

Chapter Nine provides an entrepreneurial process analysis of common themes of case company development that identifies regional enablers and constraints to commercialisation. Case companies describe network benefits, those of other initiatives and forward recommendations to improve the support environment in Scotland.

Chapter Ten discusses the role and effects of Connect among complementary support initiatives. The role of universities in supporting technology entrepreneurship is examined along with perspectives from one of Scotland's most high-profile research institutes - the Roslin Institute – on how they exploit their science and their views on the support environment in Scotland. Complementary initiatives include Scottish

Enterprise programs, university technology transfer offices, Edinburgh Technology Fund (ETF), Scottish Institute for Enterprise (SIE), the Entrepreneurial Exchange and Global Connect.

Chapter Eleven discusses Connect's evolution from a public-private program to an independent company and identifies changes to network events and activities, governance and communication mechanisms, value delivery to stakeholders and Connect's role among complementary support initiatives. The chapter also examines changes to Scotland's business environment during the timeframe of the Connect evaluation (1997-2002) to qualify network achievements and effects.

Chapter Twelve synthesises the research results from Chapters Eight through Eleven and establishes insights and key findings as they apply to the three sets of research questions.

Chapter Thirteen summarises the contributions to knowledge from the thesis and identifies research limitations and recommendations for the future. Contributions inform the application of network theory to regional support networks, network management and practice and inform the debate on intervention effects on new technology companies and the role of support networks within a regional system.

1.5 DEFINITIONS

Although the term '*new technology-based firm*' (NTBF) is widely used in the literature, debate continues over its characteristic elements and a move towards an exclusive definition. For simplicity, the thesis will consider the use of the term '*enterprise*' as appropriate and interchangeable with the terms *new company*, *new firm* or *new venture*, all used in various literatures to describe an entity established to trade in the market.

For the purposes of this thesis, it is important to establish a consistent understanding of what the term ‘network’ is meant to imply when describing Connect Scotland. The term ‘*regional support network*’ eludes a unifying definition with various definitions of innovation, business and entrepreneurial networks describing their distinctive traits, elements and dimensions (e.g. Granovetter 1992: 32; Yeung 1994: 476; Ebers 1997; Blundall and Smith 2001).

This thesis forwards a definition that refers to its primary elements; therefore the regional support network Connect Scotland will be defined as “*an integrated and co-ordinated set of formal network activities that stimulate fee-paying institutional and individual actors to socially engage and develop ongoing economic and non-economic relations that contribute to their own development, that of new companies and a sense of mutual obligation to regional development*”.

1.6 THESIS DELIMITATIONS

The problem of attribution remains in measuring Connect’s direct impact on stakeholders and new companies. A key factor is that the causal relations for these types of outcomes are influenced by factors beyond the direct impact of the Connect constituency-building process. Market conditions and economic factors are acknowledged as key factors influencing the creation and growth of technology companies, and factors such as business policies, taxation conditions, interest rates etc. have not been studied in this research. Already identified is the challenge of isolating attribution effects. However, network benefits and the influence of other support is an explicit objective of the case study analysis.

Personal traits, motivations and behaviour of stakeholders have not been measured as underlying factors in the research, although insights into individual and institutional behaviour are discussed when they appear. It is conceded that the personal traits, motivations and abilities of individuals will affect network engagement patterns,

knowledge and resource sharing behaviours and business relations that cumulatively affect network and regional support processes and outcomes.

1.7 SUMMARY

This chapter has laid the foundations for the thesis. A background to the topic, justification for undertaking research and overview of literature introduced the thesis in general terms. The research problems were identified, the methodology was briefly described and justified, definitions clarified and the limitations were given. On these foundations, the thesis will proceed with a detailed description of the research, beginning with a review of literature – Chapters Two through Six.

CHAPTER TWO

INNOVATION AND TECHNOLOGY EXPLOITATION

2.1 INTRODUCTION

This chapter begins with recent developments in the exploitation of innovations and technologies and their significant commercial importance for private and public sectors that introduce the concepts of corporate, academic and regional entrepreneurship. Included is the concept of intervention that describes the use of support mechanisms by policy-makers in particular to stimulate this exploitation.

The chapter then establishes a theoretical basis for the concepts of innovation and technology to explore key factors contributing to their commercial application. Most appropriate is a socio-economic perspective that accommodates the role of the market in selecting appropriate technologies as well as the social shaping of technology and various socially mediated factors contributing to successful exploitation and commercialisation outcomes.

2.2 RECENT DEVELOPMENTS

2.2.1 'Corporate' Entrepreneurship

The seeking and exploitation of new market opportunities by existing business is described as *corporate entrepreneurship* or 'corporate venturing' (Birkinshaw 2000). Drucker (1985: 35) refers to this search as "*systematic innovation ... the active role by a firm's leadership in looking out for market opportunities*". Drucker suggests that these opportunities include a search for the unexpected; incongruities in what is and what ought to be; changes in market structures and industry structures; new knowledge; demographic changes and changes in perceptions, moods and meanings.

According to The Economist, “innovation has become the industrial religion of the late 20th century” (“A Survey of Innovation in Industry”, Economist, Feb 28; 2002: 28). Innovation creates continuous market threats and opportunities arising from the speed of new products entering the market, short product lifecycles and global market access (e.g. D’Aveni 1994; Hamel and Prahalad 1994). Hitt, Ricart and Nixon (1998) suggest that threats are represented by the arrival of new competition and the increased uncertainty in previously protected domestic markets, while opportunities are available in new opened markets to exploit economies of scale.

De Wit and Meyer (1998: 237) describe the pressure on existing companies, stating that *“in a world of changing technologies, transforming economies, shifting demographics and dynamic competition, it is not an issue whether companies must change, but of where, how and in what direction they must change”*. They suggest that companies are increasing their focus on operational flexibility and speed to deliver faster and better products and services at lower prices.

However, Porter (1998) argues that quality, speed and flexibility will, in the long term, not be enough to create prosperity, enterprise growth and employment. These changes to how businesses respond to competitive pressures have become, according to Porter, “entrance factors” in the market place or conditions that must be met simply in order to survive. Porter argues that the source of competitive advantage for companies of today, whether at national, regional or enterprise level, is in the capacity to ‘do things differently’ and to continuously reinvent products and services.

Distinctive strategic challenges facing companies in an ‘age of innovation’ are suggested that differ significantly from the ‘industrial age’: continuous change from stability, empowerment from control, collaboration from competition, diversity from uniformity and knowledge and people centred from product and process centred (e.g. Drucker 1985; Hamel and Prahalad 1994).

Harvard Professor Clayton Christensen (1997) in his book “The Innovator’s Dilemma” argues that the failure of existing companies to stay atop their industries

when they confront technological change is often explained either by poor managerial, organisational or cultural responses or by the inability of companies to deal with radically new innovations. But Christensen proposes another explanation for competitive failures – the *value network*. He describes the value network as the context within which an existing firm identifies and responds to the market, gains knowledge and experience and develops capabilities, organisational structures and cultures tailored to their value network's distinctive requirements.

Christensen asserts that firms must continually identify the eventual flattening of their technologies while identifying new opportunities and addressing the needs of known actors within their value networks. Furthermore, he stresses that firms must consider whether the performance implications in the new innovation will be valued within the networks already serviced by the firm and whether other networks must be addressed or new ones created in order to realise value for the innovation.

A strong social dimension to corporate entrepreneurship has been identified in earlier work by Kanter (1982, 1985). Kanter (1982) suggests that a typical innovation produced within the modern business goes through several stages: 1) idea generation; 2) coalition and support building; 3) development and completion of finished product; and 4) transfer or diffusion. These stages are facilitated by organisational factors that includes experts with close links to experts in other fields, multiple communication links, small interdisciplinary business units and diversity and breadth of experience.

Kanter (1982) suggests that the development of an innovation requires three things: resources (materials, investment, space and time), information (technical knowledge, data, political intelligence and expertise) and support (legitimacy, approval and endorsement). These things are required, Kanter argues, because people initiating innovation compete in a number of markets: economic markets for resources, a marketplace of ideas for information, and a political market for support or legitimacy (Pfeffer and Salancik 1977).

Kanter suggests that *intervention* at any of her four proposed innovation stages can enhance the success and speed of the innovation process. Intervention facilitates contact and communications across boundaries within the existing structural patterns and social arrangements. Kanter's views relate to the notion of 'communication integration', close interpersonal contact and communication channels that are shown to be positively related to the rate of innovation (Rogers and Shoemaker 1971; Tushman and Nadler 1986).

Studies emphasise the importance of *value-added* provided by intervention and the various mechanisms and roles that move an innovation forward to the market (Quinn 1979; Maidique and Patch 1982). Delbecq and Mills (1985) found that innovation failures are characterised by ambivalent support, inadequate resources during the critical early stages of development, constant efforts to sell and justify the innovation and personalised infighting over resources.

Galbraith (1982) distinguishes between the roles of *sponsor*, those who discover and fund the development and testing efforts that shape an innovation, and *orchestrator*, those who manage the politics surrounding a new idea. Similarly, Van de Ven (1986), using multi-sector case studies of large innovations, found that a common need for new innovations is good management of transactions or deals over time, requiring various roles from others that secure major decisions about the project in addition to securing necessary resources.

Attainment of resources, information and support from others in innovation development is seen to lead to interdependencies between and among people and the emergence of networks of people joined through complementary interests to trade resources (Burt 1987). Burt states that networks not only lead the actor to certain resources but also suggests that networks themselves are a resource.

In his paper entitled "The Network Entrepreneur", Burt (1987) stresses that a network is a form of *social capital* which he defines as something owned jointly by the parties to a relationship and involving a rate of return realised by what is ventured

and gained by these parties. Social capital, Burt claims, is at once the structure of social associations and contacts in a network and the resources they each hold. Burt adds that social capital provides better access, better timing and an improved chance for referrals for the entrepreneur. The creation of networks, Burt suggests, often occurs to counter formal institutional rigidity and to create new types of interconnections between organisations and people.

2.2.2 'Academic' Entrepreneurship

Increasing levels of innovation exploitation are also observed in universities and research institutions across the globe, creating new products, new enterprises and new markets that contribute to economic growth (Howells *et al* 1998; AUTM 1999). The growing expectation among public policy makers that universities are engines for economic prosperity often cites the example of the US, where it is estimated that total university research adds more than US\$33.5 billion to the economy and supports 280,000 jobs annually (AUTM 1999).

The term *academic entrepreneurship* has been used to describe the commercial application of university-based research (Smilor *et al* 1993). Another term, *entrepreneurial university*, suggests the more direct involvement in the commercialisation of research activities and a more proactive approach to the role of academic research in the market place (Chrisman *et al* 1995).

Universities, it is suggested, are facing increasing pressures by governments and funding agencies who are seeking greater returns on their investment in research based on their own resource limitations (Downes and Eadie 1996; Howells *et al* 1998; Cripps *et al* 1999). Increasing financial pressures have resulted in expansion of commercialisation activities in many universities and the set-up of technology transfer offices (Gulbrandsen 1997: 128). One result is that scientists and technologists are under growing pressure to seek commercial applications for the results of their research.

At the same time, it is widely accepted that most university research is not immediately applicable in an industrial context (Howells *et al* 1998). Evidence suggests that it is an unrealistic assumption that universities function as “knowledge centres” around which innovative enterprises will cluster and where commercial success will be high (Massey, Quintas and Wield 1992).

Successful commercialisation of university-generated innovations requires other elements according to Malecki (1997), who cautions that the presence of a local university is not enough to offset shortcomings in entrepreneurial climate. Similarly, Walshok (1994) argues that university-industry exploitation partnerships cannot achieve their intended consequences without parallel and reinforcing knowledge linkages which assure a policy environment supportive of economic growth, a regional infrastructure ready to support new and renewing industries and an appropriately competent, informed professional and technical labour force.

2.2.3 ‘Regional’ Entrepreneurship

The concept of *regional entrepreneurship* is based on research showing that the spread of innovations and commercial success is a function of the support that innovators can draw from the larger community as well as industry conditions (Pfeffer and Salancik 1977; Vaughn 1983; Ruttan and Hayami 1984; Saxenian 1994; Van de Ven 1993; Porter 1990, 1998). As noted earlier, it is acknowledged that a university is but one of the elements in the support structure to create and develop new enterprises (Walshok 1994; Maleki 1997; Botham and Eadie 1997).

Regional factors include access to investors and those funding technology-based enterprises, small to medium-sized enterprises that may collaborate with universities in new company formation, service providers of marketing, management and technology verification, or due diligence services and others that exist in the region to promote and support the development of start-up enterprises. Further evidence

suggests that regional factors strongly influence the creation of successful start-ups enterprises (Cook and Morgan 1993; Porter 1990; Malecki 1997).

Research on successful high technology regions, such as Silicon Valley, Cambridge, UK and Cambridge, Massachusetts points out the critical importance of a supportive infrastructure for new and growing firms (Saxenian 1990, 1994; Segal *et al* 1985, 2000). These elements include tax incentives, the provision of business parks and programs that facilitate supportive agents that understand the needs and requirements of emerging and existing firms. As well, the notion of *networks* and the benefits of participation and associated competitive advantages is identified in regional economic development policy literature (Ritsila 1999).

2.2.4 Market Intervention and Enterprise Support

Technology-based innovations and sectors are viewed by policy-makers as having the greatest potential to generate future economic benefits. High technology companies are thought to have greater growth potential than conventional firms as well as to be better ‘converters’ of science into marketable products than larger firms (Lalkaka and Abetti, 1998; Deakins *et al*, 1998; Gregory and Martin, 1998).

Government intervention, it is argued, is required that stimulates creation of supportive agents and thus a critical mass of competitive firms can be established that make an impact on the regional economy. Regional economic development agencies all over the world have invested public money into schemes to facilitate and strengthen particular kinds of local networks in the belief that these support local competitive advantages and give rise to additional capital investment, employment and higher new business birth-rates.

David Rosenberg, in his book “Cloning Silicon Valley” (2002), provides evidence that virtually every developed country in the world today is building or aspires to build its own innovation region using California’s Silicon Valley as an example. The

Silicon Valley region provides one of the first 'ideal models' with high levels of technology-based enterprises underpinning a dynamic, high-growth regional economy that other regions sought to emulate.

According to the Commission of the European Communities (OECD 1998), intervention initiatives in Western Europe have focused on three principal objectives:

1. reduction of the economic, social and political cost of widespread unemployment;
2. increase in activity in the SME sector leading to economic development, technological innovation and industrial restructuring; and
3. creation of an enterprise culture and the widening of entrepreneurship.

More recent regional initiatives, such as the Regional Innovation Strategies of the European Union, are focused on creating conditions that facilitate new enterprises and contribute to economic growth and prosperity.

2.3 DESCRIBING INNOVATION AND TECHNOLOGY

This section describes the concepts of innovation and technology to establish the elements, processes and factors contributing to commercial exploitation. *Innovation* is defined by Afuah (1998) as the sum of invention plus the commercialisation of that invention and by Collins (1997) as 'something newly introduced, such as a new method or device'. Innovations are also described as representing additions to existing knowledge, but are more broadly defined than inventions to include processes or new ways of doing things (Blaug 1963; Martin, 1994).

Invention as a sub-set of innovation has been defined as '*something new that is thought up or created*' (Collins 1997), and as a sequence of acts of insight, which lead to a cumulative synthesis of many items that were originally independent (Usher 1955). Casson (1982: 375) asserts that invention, as the precursor of innovation, "is a field of imaginative activity outside the province of the entrepreneur". Casson's

assertion is supported by the fact that the foundation for many inventions is scientific knowledge derived through applied or basic research activities¹. Casson argues that entrepreneurs may transform the invention into a commercial entity but may not be involved in its creation.

Many opportunities to exploit technological innovations begin with scientific advances (Nelson and Winter 1982; Dosi 1988) and from scientific knowledge that includes the production of facts or data observed in reproducible experiments and theories or relationships between facts (Nelson 1959). Nelson points out that advances in scientific knowledge are often not directly and immediately applicable to the solutions of practical problems, and he asserts that social gains arising from advances of knowledge are primarily from basic research efforts. Nelson suggests that because applied research is constrained to the solution of a specific practical problem, it is relatively unlikely to result in significant breakthroughs in scientific knowledge save by accident.

Not all inventions lead to innovation, as many inventions become a valuable input for other research projects (Usher 1955; Nelson 1959). According to Nelson (1959: 301), this is why many academics argue for free and wide communication of research results, [as] *new knowledge is of greatest value as a key input of other research projects which, in turn, may yield results of practical and patentable value*".

'Technology' is also a related concept to innovation, described as a social construct that relates to its interpretation and use by people (Liebeskind 1996; Cohen and Levinthal, 1990) and as a product of human ingenuity, with changes in technology representing changes in knowledge (Mokyr 1990). Technology is also referred to as a '*cultural system concerned with the relationships between humans and their environment*' (Tepstra and David 1985: 148).

¹ Scientific research is commonly categorised as basic, in referring to activities involved in generating new knowledge, and applied, referring to research geared toward solving particular problems (Nelson 1959; Burgelman *et al* 1996).

Coombs and Richards (1991) describe technology in terms of its commercial application, as ‘units’ of knowledge and expertise that influence product development in a variety of ways that are, more or less, specific to a commercial application. Similarly, Autio views technology as a social construct created by people to gain commercial success (Autio 2000).

2.3.1 Economic Perspectives

Neo-classical economists generally view the development of scientific knowledge into technological innovations as a production function involving the transformation of inputs into outputs, with this transformation following a *linear progression* from invention to application (Crew 1975; Hunt 2000). Faulkner and Senker (1995: 26) suggest the linear model commences at the ‘springhead’ – the creation of new knowledge – and leads to technological innovations and economic growth.

Undertaking innovation development for commercial gain, economists argue, will occur only if favourable macro-economic and product market conditions are present (e.g. Audretsch 1993; Karlsson *et al* 1993). Prices provide the information necessary to undertake effort but only if the expected revenue of the effort exceed the expected cost (Nelson 1959; Blaug 1963; Schmookler 1962).

Mowery and Rosenberg (1979) argue that three kinds of resources are critical to the development of most technologies: 1) basic scientific or technological research; 2) financing mechanisms; and 3) a pool of competent human resources. They suggest that basic knowledge is very costly to produce relative to the cost of diffusion and imitation and typically public organisations such as universities and research centres play a key role in creating and providing this knowledge. In contrast, financing requirements to develop technologies usually arise from the market rather than public sources (Van de Van 1993).

Indeed, economists such as Nelson (1959) and Arrow (1962) assert that social returns to research investment exceed any private returns to the market, creating a common problem of under-investment by firms in research and development. For example, Arrow proposes a development profitability function that provides the initial motivation to proceed with innovation development, (expressing profitability in production conditional on development expenditures) that is affected by how much is known regarding the market for the innovation. According to Arrow, *demand or market pull* requires the existence of markets for innovations that provides differential incentive structures for undertaking research commercialisation.

Evidence suggests that determining the costs and benefits of potential commercial application first require an understanding of the nature of technological development. Burgelman *et al* (1996) suggest three different types of 'technological innovations'. Incremental innovations involve the adaptation, refinement and enhancement of existing products; radical innovations involve entirely new product categories; and architectural innovations are configurations of systems of components that constitute a product.

Casson (1982) suggests that an entirely new innovation, or radical innovation, incurs a set-up cost which is a fixed cost independent of output, or opportunity cost. This involves synthesising technical information with information about the scarcity of factors of production in order to assess whether the new innovation, besides its technical virtues, will also reduce costs of production. A differentiated innovation or version of an existing product infers that the demand for the new variant at any price is governed by the prices of the existing variant. In this case, Casson argues that the entrepreneur needs to synthesise information about buyer preferences for product quality with information about costs of the new design. Other information costs can include the search for contractual partners, contract costs, and monitoring technical production and quality (Foss, 1994).

Various arguments are forwarded to counter the demand pull theory of innovation development and linear models. White identifies that a problem in anticipating

future profits is the creation of new innovations, arguing that existing prices in the market cannot explain new 'innovations' "... *for the notion of discovering price discrepancies is severely strained in a situation where no prices of any kind (let alone future prices) exist for the new-and-different commodities under consideration*" (White 1976: 95).

Mowery and Rosenberg (1979) suggest a balancing act in exploiting a technological innovation and dismiss outright arguments that innovations arise from market demand. They accept that expectations of future profits are based on a market demand sufficiently large enough to justify expenditure. At the same time, they argue that the range of actions that are available and their respective costs are continually being altered by the course of technical progress and thus the costs of alternative actions for investment are always changing.

An alternative view of successful innovation development is their emergence through the combination of identified market opportunity and suitable technological development (Freeman 1982; Coombs *et al* 1987). For example, literature suggests that an identified market need occurs more often in applied research involving industry partners and less so in the case of a scientific discovery arising out of basic research (Kline and Rosenberg 1986; AUTM 1999). Cripps *et al* (1999) argue that academic research may or may not be focused on finding technical and commercial solutions to existing or often unforeseen market opportunities, and thus they dismiss conventional linear models of product innovation as not so relevant to universities. They also assert that research behind the innovation is only the first and usually the least expensive stage in commercialisation of technology innovation.

A model by Yong Lee and Gaertner (1994) in Figure 2.1 suggests that 'market pull' from an identified market need not be the starting point for innovation development and commercialisation. Rather, the starting point may be from basic research, with commercialisation possibilities feeding back to modify or redesign the research.

Figure 2.1: University Model of Technological Innovation
(adapted from Yong Lee and Gaertner 1994)

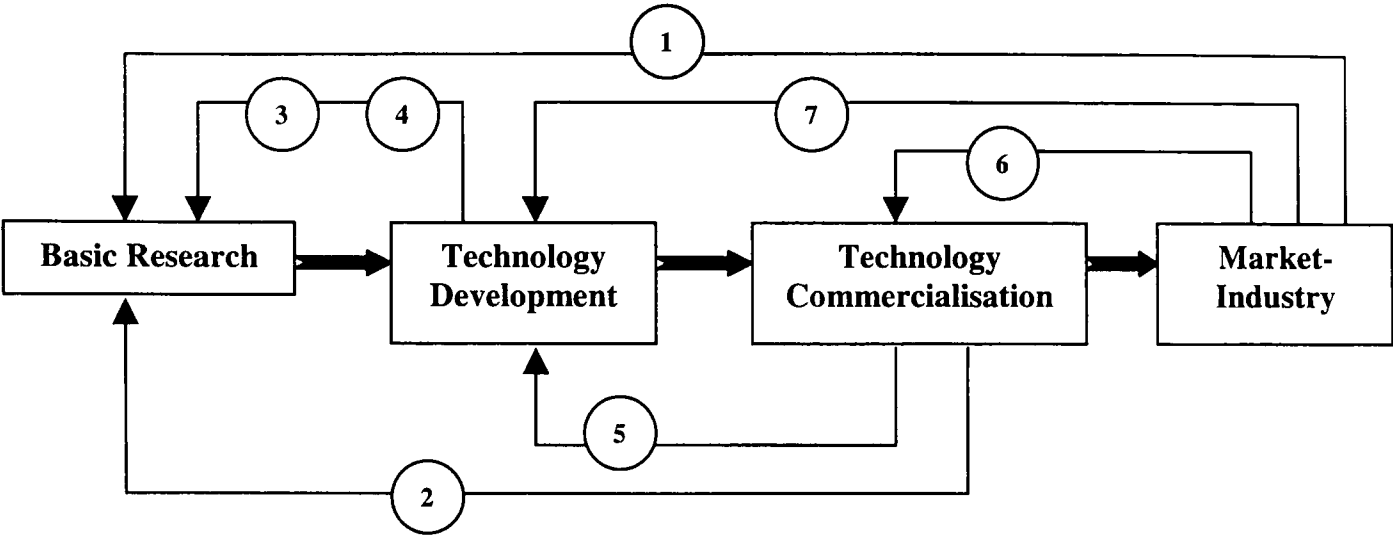


Figure Legend:

- | | | | |
|-----|---------------------------------|---|-----------------------------------|
| 1&7 | Market needs | 4 | Further research-problem solving |
| 2 | Commercialisation possibilities | 5 | Design, redesign, further testing |
| 3 | Technological feasibility | 6 | Quality improvement, economising |

This model shows that each of the four stages of the process may or may not continue (wide arrows) to progress to the right depending on results of the feedback mechanisms. Contributions of the market end user (number 1&7 above) in technological development acknowledge the variation by industrial sector of producer and user input in innovation development.

Sectoral conditions, noted in the Yong Lee and Gaertner model, have been identified in earlier research as an important factor affecting innovation development. Von Hippel (1978) found new industrial product development is characterised by a much high level of customer activity than consumer products. He suggests that the appropriateness of the innovation benefits will determine the level of user or producer interaction in innovation development. Levin *et al* (1984: 33) find that for most industries, factors such as learning curve advantages and lead times, combined with complementary marketing efforts, provide the principle mechanisms of realising returns on investments in product innovations. Similarly, Dosi (1988) argues that some sectors and technologies may rely on informal processes of learning-by-doing and design improvements while others rely more on formal search activities in research laboratories.

Dosi (1988: 222) further argues that innovation development is more application-focused in suggesting that innovation concerns the search for, and the discovery, experimentation, development, imitation and adoption of new products, new production processes and new organisational set-ups. Dosi suggests that the technical and commercial outcomes of innovative efforts are difficult to know *ex ante* and thus innovation involves a fundamental element of uncertainty - the lack of all relevant information about known events and the existence of techno-economic problems whose solutions are unknown.

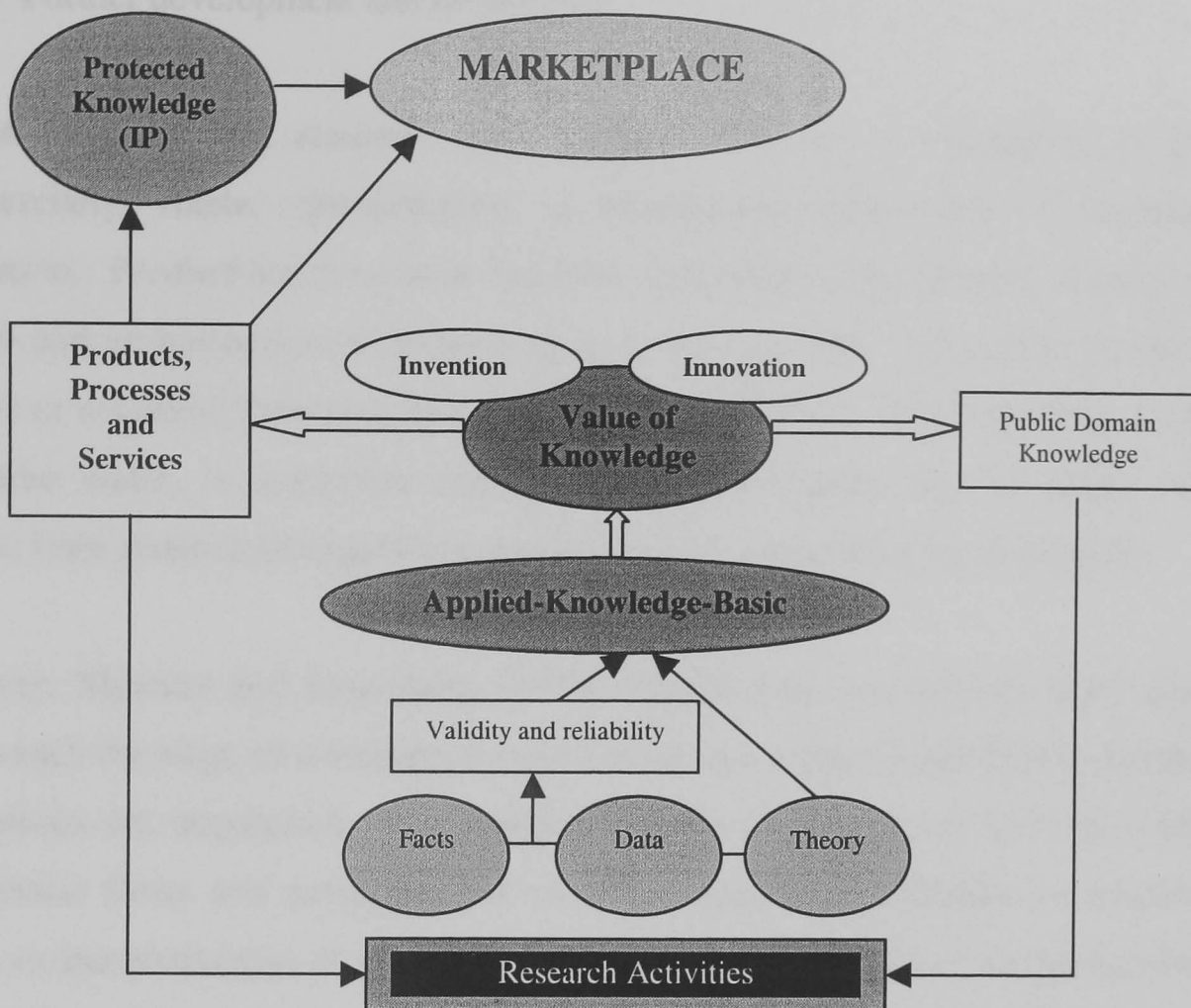
2.3.2 Exploitation and Commercialisation

The suggested risk and uncertainty of science-based innovation development is often synonymous with protection of an innovation's intellectual property (IP) and is normally one of the first commercial activities in attempting to exploit private or public sector research. Securing IP is based on the argument that profit cannot be secured unless the introduction of the new knowledge or invention can be controlled through patent privileges (Usher 1955; AUTM 1999; Howells *et al* 1998). According to Casson (1982), securing IP is the reward for entrepreneurial judgement, providing the entrepreneur with monopoly power and guaranteeing first-advantage and a level of privileged information that others do not possess. Protection of IP is also based on the premise that many innovations are hard to produce but easier to copy (Chidamber and Kon 1994).

Figure 2.2 synthesises previous perspectives on knowledge, invention and innovation by showing the flow of research activity leading to an innovation being identified as having potential commercial value through the protection of its intellectual property.

Figure 2.2: Flow of Research Activities to Marketplace

(adapted from Usher 1955; Nelson 1959; Schmookler 1962;
Burgelman *et al* 1996; Tait and Williams 1999)



According to the Association of University Technology Managers (AUTM 1999), an international association promoting academic technology transfer practices, *commercialisation* commences with the research idea as it relates to commercial potential, and moves through to market entry, when products, processes or services based on the research are sold. AUTM proposes seven stages of the commercialisation process:

- Identification of potential commercial applications of research
- Recognition by the market (industry) of the potential of research in a specific application; verifying the significance of the research
- Development of technology to 'proof on concept' in the field of application
- Assessment of market potential, which may feed back information on required performance criteria
- Design, prototype development and testing

- Commercial-scale manufacturing and market entry strategies, including access to appropriate distribution channels
- Further development and refinement

AUTM suggests that research may already exist that is identified as being commercially viable, characterising a product-led rather than a market-led innovation. *Product-led* innovation has been described as the process of converting science and technology, new research or an invention, into a successful marketable product or industrial processes (Scottish Enterprise 1996: 2). This objective, Scottish Enterprise states, is concerned with *all* the transfer routes and all stages of the process from research through to the marketing and manufacturing of products.

However, Mowery and Rosenberg (1979) suggest that not only do most patents never reach the stage of commercial exploitation, but many commercially successful innovations are unpatented. They argue that the production of new knowledge, information flows and processes that underlie, shape and contribute to success or failure in the production of an innovation are inadequately served by market forces and the incentives of the marketplace. In their assessment of post-war American technical dynamism, Mowery and Rosenberg assert this has been the direct outgrowth of scientific and technical research (often funded and justified by defence requirements) rather than a response to sudden shifts or increases in market demand. Process innovations grounded in theoretical and technical developments, they suggest, have been fundamental to product innovations.

Technological opportunities, according to Dosi (1988) depend on the nature of each techno-economic paradigm and the economic and institutional context of each country. Dosi explains that technological advances normally draw upon the availability of some sub-set of publicly available knowledge that is improved upon by highly selected scientific and technological knowledge intent on solving specific problems or applications. Dosi suggests that the ‘public’ characteristics of technology relate to the *untraded interdependencies* between technologies, enterprises and sectors that provide a structured set of technological externalities

within a collective and regional context. Thus, the technology itself and the external context determine both the opportunities and the boundaries for technological progress.

In line with Dosi's insights, Tait and Williams (1999) argue that the linear model ignores key innovative contributions by commercial organisations in the conversion of knowledge into marketable products and processes and their role as creators of knowledge in their own right.

2.3.2.1 Technology Transfer

Previous arguments lead to questions on the processes most appropriate and effective for commercial exploitation. For many universities and research institutions world-wide, commercialisation is synonymous with *technology transfer*.

AUTM defines technology transfer as '*a formal transferring of new discoveries and innovations resulting from scientific research conducted at universities to the commercial sector*'. Technology transfer processes within this definition include: 1) the disclosure of innovations; 2) patenting the innovation's *intellectual property* (IP) concurrent with publication of scientific research; and 3) licensing the rights to innovations to industry for commercial development.

Rogers *et al* (1999) suggest that success of technology transfer is measured in a variety of ways that include number of patents filed, license agreements executed and new companies formed as well as royalties paid to the academic institutions from companies that commercialise their inventions and the numbers of products successfully introduced to the market. AUTM suggests simple models for calculating the public benefits of their activities, including induced investment, return to licensee/investor, taxes, and jobs. Non-numerical measures of success include a university's capability to retain entrepreneurial faculty and attract outstanding graduate students; its reputation for innovation; the enhancement of

university research through interaction with the private sector; and, its reputation for providing highly trained students for the industrial workforce.

Studies suggest a number of factors why most university research is not immediately applicable in an industrial context. A report by Howells *et al* (1998) surveyed 109 UK universities on their linkages with industry and found that many universities are limited to licensing their IP because of issues with industry affecting technology transfer. These issues included the role of research, institutional traditions, university competencies and resources and former experiences in co-operation and depth of previous linkages that can constrain the potential diffusion of technology and co-operation between universities and industrial partners. Another factor cited is that many universities do not have the resources or capabilities to fully commercialise intellectual property (Howells *et al* 1998, AUTM 1999).

Although returns are expected from a variety of strategies - royalty streams, licensing fees or science park rents, for example – starting new enterprises are seen by university administrators and policymakers in the UK and other western countries as having high economic value (Lalkaka and Abetti, 1998; Deakins *et al*, 1998; Gregory and Martin, 1998; Oakey and Rothwell, 1986). Exploitation of IP through the creation of a new enterprise, it is argued, can provide higher returns but also requires a longer time horizon to realise.

2.3.3 Sociological Perspectives of Innovation Development

Various arguments and theories counter the neo-classical notion that technology follows a simple linear progression from invention to application, with economic agents applying rational and maximising behaviour and actions. Technological innovations and their applications are known to co-evolve in unpredictable ways, influenced by social and cognitive factors and by the nature of the technological system (Nelson and Winter 1977, 1982; Rosenberg 1969; Sahal 1985).

Various theories provide the argument that technologies are socially shaped (Coombs *et al* 1992). At one level, the sociological debate challenges the linear argument of innovation development. For example, Mowery and Rosenberg (1979) argue that while one may rely upon the ordinary forces of the marketplace to bring about a rapid diffusion of an existing innovation with good profit prospects, these same forces cannot account for the initial generation of such innovations. Kline and Rosenberg (1986: 275) argue that commercialisation of a technology innovation is a more complex and challenging proposition, stating that:

“Models that depict innovation as a smooth, well-behaved linear process badly misspecify the nature and direction of the causal factors at work. Innovation is complex, uncertain, somewhat disorderly and subject to changes of many sorts...The systems used...are among the most complex known (both technically and socially), and the requirements for successful innovation vary greatly from case to case”.

The concepts of *technological trajectory* (Nelson and Winter 1977; Dosi 1982) and *techno-economic paradigm* (Freeman and Perez 1988) suggest the strong influence of the technology itself – on cumulative knowledge and technological competencies of economic agents - *and* organisational procedures of agents that limit certain activities and choices. Innovative learning as well may be paradigm-bound and occur along particular trajectories.

Nelson and Winter (1982) suggest innovation as new knowledge is affected by the common store of beliefs held by the technological community on what can or should be attempted. Their notion of *technological regime* acknowledges that, while there is a cumulative nature to technological development, this development follows a trajectory influenced by the body of knowledge and expectations held by a community of practitioners. They further argue that innovative performance and technology development are strongly path-dependent, resulting in different ways of responding to the same external changes, resulting in variations in profitability and growth. The notion of path dependence suggests that existing capabilities are built up over time, providing a starting point from which new developments proceed.

Chidamber and Kon (1994) suggest that neo-classical innovation models ignore the importance of existing technological capabilities and the need to defend them. In addition to these social and cognitive factors affecting innovation development, highlighted by Nelson and Winter, the size and structure of the technological system itself affects innovation development by generating *guideposts* along which development is constrained (Rosenberg 1969; Sahal 1985).

Georghiou *et al* (1986) point out that innovations seldom emerge fully formed, and that success or failure of a new development depends on the sequence of interrelated innovations that diffuse through the economy following the initial introduction of the innovation. They interpret the concept of technological regime as a basic set of design parameters along with a related body of knowledge regarding the potential physical characteristics, materials and processes that will contribute to the final product. What design configuration actually emerges from a number of possible options will be determined by ongoing evolutionary developments within a particular configuration or by the emergence of new design configurations.

The notion of exploitation uncertainty noted by Mowery and Rosenberg is also explained according to the ability of those attempting to exploit. Taking technology transfer, it is suggested that social factors – i.e. the role of other people and influences of strategic intent, among others - affect the mechanisms and intentions that will influence developmental and exploitation processes.

Rosenberg (1976) argues that the collective context may enable or constrain technological progress in countries, regions or organisations. Whether it is the unintentional outcome of decentralised processes in a regional context or the result of explicit strategies by public and private institutions, different incentives and constraints may arise given a set of economic signals. All the economic agents operating on a particular technology, for example, may be constrained by what they have been capable of doing in the past.

Actor network theory, based on work by Callon (1987, 1992) and others, expand the collective context suggested by Rosenberg to provide a more holistic account of multiple agents and institutional factors affecting innovation progress.

Callon (1987) suggests that technological change cannot be reduced to autonomous social, economic or technical influences, but rather must account for an array of heterogeneous actors that are mobilised in technological development. These include social, individual, institutional and other actors that together constitute a 'seamless web' that derives its influences from these actors and the interrelationships between them. Interrelationships are reflected in *intermediaries*, defined by Callon as those entities, people, knowledge, skills, financial resources, or combinations that can be attributed to these actors.

Callon describes the concept of Techno-Economic Network (TEN) that links all the *intermediation* activities of all actors who are collectively involved in the development of technological knowledge and innovations (Callon 1992). He describes the notion of the *long network* that comprises scientific, technical and market *poles*, and the *short network* that only includes the technical and market *poles*. An ongoing function within the TEN are the acts of *definition* and *translation* among actors and intermediaries to provide an inter-definition of roles and activities and a level of alignment of entities when translation is successful.

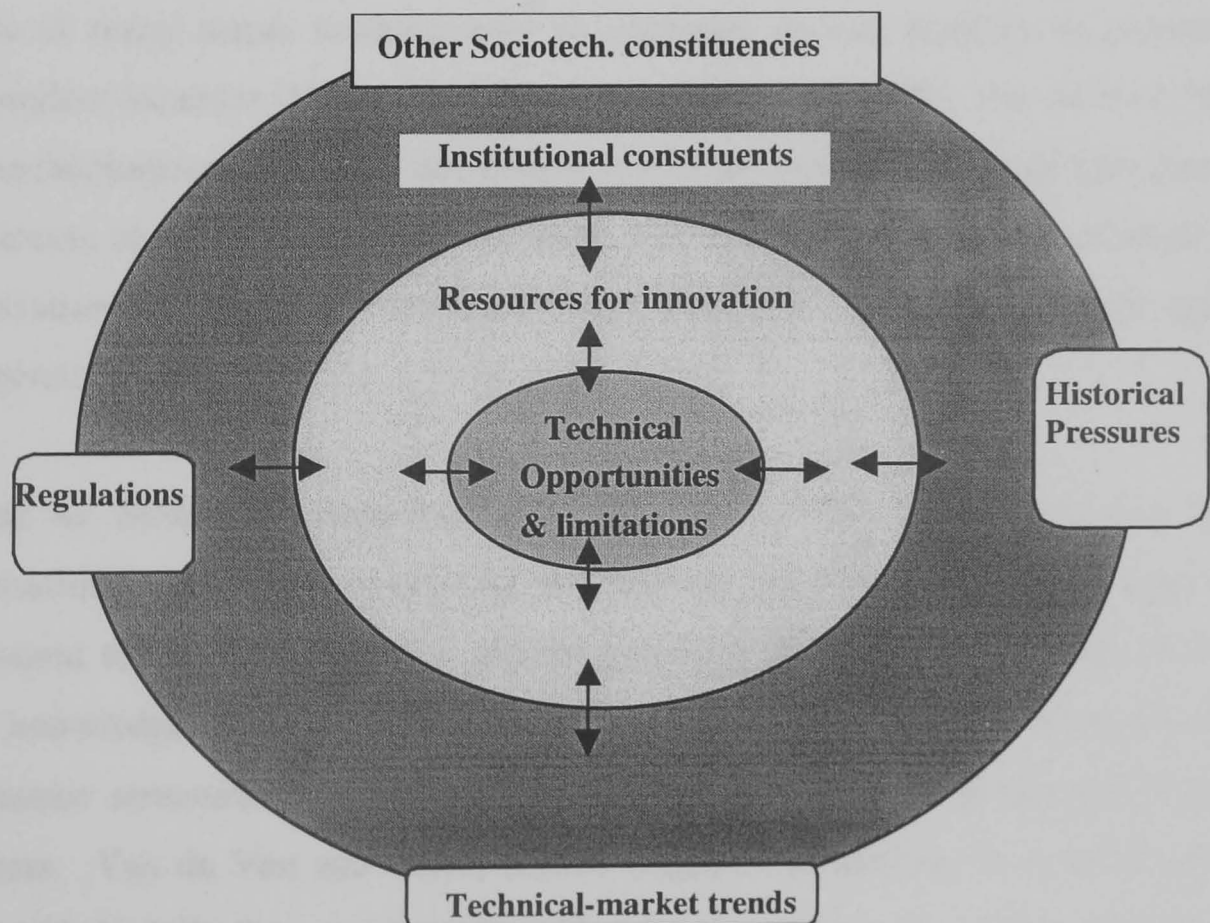
An important consequence of definition and translation within the TEN is that rules and procedures may emerge to co-ordinate these activities. When co-ordination and alignment are strong, the network may reflect formal norms that in turn establish a more predictable and identifiable network, said to be *convergent*. A further characteristic of the network may be its *irreversibility* that provides network stability by standardising identities, relationships and routines with the network's boundaries that are identifiable by those within as well as without the network.

Implications of actor network theory on innovation and technological development is suggested by the ability to predict, model or quantify the processes within the network that can lead to them being ‘black-boxed ‘ and used as inputs into other networks. At the same time, a holistic emphasis on all actors and intermediaries suggests that if the association of an actor changes, then the translation is no longer predictable, and the network becomes less convergent and more reversible.

2.3.3.2 Sociotechnical Constituencies

Similar to actor network theory, Molina’s (1990, 1995, 1997, 1998) concept of *sociotechnical constituencies* describes technological development as the result of a combination of people skills and knowledge, physical and financial resources and the interactions between these elements. Molina proposes a model that places greater importance on the *constituencies* – the institutions, social groups and people that shape technological development (Figure 2.3).

Figure 2.3: Sociotechnical Constituency Model Representation



(Adapted from Molina 1990: 311)

The model emphasises that interactions, within as well as external to the specific technical constituency, occur at three levels – technical, resources and social-institutional. A two-way flow of exchange occurs among these levels and between these levels and external factors influencing the constituency, e.g. other constituencies, technical and markets trends, competition, regulations and historical circumstances.

Molina's model recognises the limitations of actor network theory by considering the importance of non-technical factors that shape technological development. These factors include the role of individuals, institutions, government policies, commercial and economic activity that affect and are affected by activities within each technical constituency and among constituencies. For example, literature suggests that a variety of government regulations and institutional arrangements facilitate or inhibit the emergence of new technologies and industries (Nelson and Winter 1982; Van de Ven 1993).

A key element of Molina's model - collective technological development - reinforces earlier research emphasising that most innovations are collective achievements of the efforts of many actors working over an extended period, possibly in parallel or independent locations (Usher 1954; Rosenberg 1983; Dosi 1988; Van de Ven 1993). New technologies, it is argued, are seldom if ever developed by a single firm alone in the vacuum of an institutional environment, with many complementary technical and organisational arrangements necessary before a particular technology can be applied commercially.

Similar to Molina's perspective, Van de Ven (1993) argues that the inter-organisational community or network is a relevant unit of analysis if one aspires to understand the *infrastructure for entrepreneurship* that includes functions such as basic knowledge, financing mechanisms, competent labor as well as institutional governance structures that legitimize, regulated and standardise the activities of members. Van de Ven and Garud (1989) suggest that analysis of a social system framework include the opportunistic and collective efforts of various independent

actors in common pursuit of technological innovation. These actors include not only the developers of innovations but also the many other public and private sector actors who perform critical functions to develop and commercialise a new technology.

Dosi (1988: 234) also argues that any interpretation of innovative processes must also account for the *evolutionary environment* within which these processes are situated and the evolving nature of activities by economic agents that will contribute or constrain innovative outcomes. Dosi states that the uncertainties of the innovative process is based upon problem solving and search activities of varying combinations of public and private people and institutions – encompassing knowledge science, experiences, procedures and competencies.

Dosi goes on to suggest that innovative opportunities and their economic exploitation co-evolve in ways that are at least partly endogenous to the process of discovery, development and production. He adds that entire communities of economic and technological actors imply different opportunities for innovation exploitation and economic benefits based on differences among countries, sectors, institutions and actors that create *asymmetries* in product technologies, production and search efficiencies as well as in knowledge, experiences and competencies.

A similar evolutionary view by Mowery and Rosenberg (1979) asserts that the economic argument of ‘inputs in – innovations’ out fails to account for the growth and evolution of a given organisational form involved in the research and innovation processes. This includes the interface between successful public and private development efforts and efforts and policies that encourage the interaction of users and producers and between more basic and applied research enterprises.

Mowery and Rosenberg suggest that appropriate public policies can increase both the frequency and intimacy of interactions among these separate participant groups. This involves not only expanding the network on which information may flow among these groups but includes measures that increase the incentive to participate in such interactions.

Returning to earlier descriptions on corporate entrepreneurship, it was suggested that it is the *entrepreneur* or innovator whose role is to obtain the desired support and contribution from others that include offers of financial incentives, resources, information, policy promises, learning experience and personal development (Burt 1987; Kanter 1982). Indeed, a more informed description of factors affecting innovation development and exploitation benefits from contributions of entrepreneurial literature. The role of the entrepreneur and processes of entrepreneurship as factors in innovation exploitation are explored in Chapter Three.

2.4 SUMMARY

This chapter has highlighted the growing emphasis placed on innovation exploitation and how a range of capabilities and market conditions are necessary for successful exploitation. Economic arguments emphasise the market as the main selection criteria that ‘pulls’ innovation development towards a market application, although this argument is less relevant to basis research activities. Social theories counter linear and market demand accounts of innovation development to market by suggesting trajectories, path dependencies and constraints to processes and strategies affect the frameworks in which innovation development can occur. Learning processes among actors and between users and suppliers will also affect not only the patterns of decision selection but also the availability of choices in development and exploitation.

Literature suggests that capabilities to *exploit* innovations are different than those to develop innovations for commercial application. Actor network theory and Molina’s ‘sociotechnical constituency’ perspectives emphasise the importance of social and cognitive, technical and non-technical, actors and their interrelationships. Contributions from corporate entrepreneurship literature and social systems perspectives describe innovation exploitation as processes requiring access to resources and capabilities held by various actors and organisations often external to the source of innovation development.

Descriptions of academic entrepreneurship suggest that universities provide a number of initial exploitation functions, such as IP protection. However, most universities rely on external support from public and private sources to secure investment, provide due diligence of technology, secure professional management and supply channels among others.

These socio-economic perspectives of innovation development and exploitation emphasis successful innovation exploitation as collective achievements, influenced by the body of knowledge and expectations held by technical and economic agents involved with the innovation. This wider community is described in the literature by various terms: the 'evolutionary environment' (Dosi 1988), the 'infrastructure for entrepreneurship' (Van de Ven 1993), the 'sociotechnical constituency' (Molina 1990), the 'techno-economic network' (Callon 1987) and the 'value network' Christensen (1997), among others. A common feature of these concepts is their emphasis on the context within which those attempting to develop and commercially exploit innovations gain support, knowledge and experience and develop capabilities, resources and exploitation strategies appropriate to the innovation's distinctive requirements.

Implications from this literature to the research intent of the thesis emphasise the individual and collective actions of technical and economic actors and the regional socio-economic context in which these actors are active and certain market conditions prevail. For regions where collective action and regional conditions to successfully develop and exploit innovation have not developed 'naturally', intervention efforts have attempted to create an enabling context. Indeed, the creation of a regional support network to stimulate these actions and create a support context lies at the centre of this thesis.

CHAPTER THREE

THEORIES AND PERSPECTIVES OF ENTREPRENEURSHIP

3.1. INTRODUCTION

This chapter explores theories of entrepreneurship, beginning with Joseph Schumpeter, who discusses innovation, entrepreneurship and their effects on economic development. The role of the entrepreneur, processes of enterprise creation and growth are discussed through various 'theories of the firm' and evolutionary growth theories that describe how resource and capability requirements change during start-up, formation and growth periods.

The chapter discusses the social structure of markets, societal attitudes to entrepreneurship and the role of networks of individuals and institutions that influence entrepreneurial activities and outcomes. The chapter then discusses external factors, sectoral conditions and their effects on enterprise and entrepreneurial strategies. Further discussion of technology-based entrepreneurship will be undertaken in Chapter Five

3.2 INNOVATION AND ENTREPRENEURSHIP

Entrepreneurship is commonly associated with innovation when describing the processes, behaviour and decisions in taking innovations to the marketplace. Mowery (1985) describes entrepreneurship as a staged process of transforming technological knowledge by private enterprises into proprietary innovations that can become commercial monopolies. Van de Ven (1993) describes the micro-level actions of *entrepreneurs* – those individuals in private firms, research institutes, government departments, etc. – that are instrumental in enacting and changing the social system to exploit innovations.

The social system perspectives described earlier suggest that processes of innovation are collective achievements requiring key roles from numerous actors, often from both the public and private sectors. At the same time, economic perspectives emphasise that market forces and external factors characterising an economy or industrial sector significantly affect opportunities for economic gains from innovation exploitation and consequently affect innovation development – particularly the role of private sector actors who provide investment and take on risk in conditions of high uncertainty.

The relationship between entrepreneurship and innovation, in particular – the creation of new market opportunities through the introduction of new innovations - is largely from the work by Joseph Schumpeter (1934, 1951, 1954). Schumpeter emphasises the formation of new businesses as the single most important indicator of entrepreneurship (Foreman-Peck 1985). This formation is the primary responsibility of the entrepreneur, who is expected to co-ordinate resources that depend on the entrepreneur's privileged access to information. Schumpeter's entrepreneur plays a central role in initiating economic change and engaging in 'creative destruction' by enacting states of disequilibrium through innovative activities.

Schumpeter introduces an economic model of circular flows in which the entrepreneur disrupts markets and causes new markets to be formed with new combinations he calls 'innovations' (Schumpeter 1934). He defines innovations in terms of transformation of the organisation of the enterprise, or the composition of forces within a sector or market, rather than technical invention or technical change. Five entrepreneurial activities that characterise innovations are the introduction of a new good, a new method of production, the opening of a new market, a new source of supply of raw materials and the carrying out of a new form of organisation.

For Schumpeter, innovative activities destabilise markets and destroy the advantages of established enterprises. These actions are imitated by other enterprises, and finally markets return to equilibrium until the next wave of innovations begins the process again (Schumpeter 1934). Entrepreneurship lifts the economy from one state

of equilibrium to another, by entrepreneurs who are motivated in seeking above-average returns that are expected to result from innovations.

Schumpeter (1934) views the separation of the entrepreneur, acting as an independent agent, with entrepreneurship, seen as a process of activities leading to economic development. This separation has provided a vacuum in Schumpeter's account of innovation and entrepreneurship that has provided the stimulus for others perspectives.

According to Baumol (1990), one limitation of Schumpeter's theory is the absence of an explanation on factors that determine the allocation of entrepreneurial inputs among Schumpeter's five entrepreneurial activities. Baumol alludes to resource co-ordination that is not specified but assumed to include both the process of creating 'new combinations' and acquiring necessary resources for a new enterprise. Similarly, De Vecchi (1995) suggests that Schumpeter does not identify the 'processes' leading to innovation opportunity identification, the procurement of resources that include outside capital and the alignment of resources to innovation requirements.

3.2.1 Further Descriptions of Entrepreneurship

Drawing from Schumpeter's definition and those of others, 'entrepreneurship' is a multi-disciplined phenomenon that encompasses contributions from economics, sociology, psychology, cultural studies, and strategic management and organisation science, among others (Herron *et al* 1992; Venkatraman 1997). Schumpeter also stresses the importance of insights from both theory and practice and suggested that understanding entrepreneurship includes the actual activity of the entrepreneur, rather than simply preconceived notions by economic theorists (Swedberg 2002: 17).

Entrepreneurship is described as a multi-faceted factor that includes the *behaviour* that transforms innovation into market opportunities (Drucker 1985; Venkatraman

1997; Hitt 2000) and *commercialisation processes*, described by Hitt (2000:4) “[as a way of] thinking and doing things that transforms innovation into market opportunities or competitive advantage”. Schumpeter’s definition of innovation – as new resource combinations – is similar to Hitt’s description of commercialisation processes.

In the absence of a unifying definition, entrepreneurship is described as a predisposition towards proactive and risk-taking behaviour (Birkinshaw 2000); a ‘clear departure from existing practices’ (Damanpour, 1991: 561), and use of resources beyond the individual’s direct control (Penrose 1959; Stevenson and Jarillo 1990). Entrepreneurship is also described as a pattern of management behaviour (organisational routines, processes and management styles) that has an innovative outcome.

New perspectives and theories continue to expand the realm of entrepreneurship research; in particular, social theories and theories arising from economic geography. For example, more recent literature emphasising the importance of considering entrepreneurship and enterprise in a local as well as global context places importance on theories of collaborative entrepreneurship, industrial clusters and networking (Venkatraman 1997; Malecki 1997; Barney 2000; Hitt 2000).

More explicit in enterprise literature are evolutionary perspectives of development and growth as competencies and resources are built up within organisational structures, with the innovation becoming one of a number of ‘enterprise competencies’.

3.3 ECONOMIC PERSPECTIVES

Entrepreneurship is described – particularly in neo-classical terms - as the *search for profit opportunities* in the market, with profit providing the necessary prerequisite to motivating economic behaviour, stimulating activity and providing direction for entrepreneurial market activities (Mises, 1976, Schumpeter 1934; Baumol 1995).

Identifying profit opportunities is guided by the price mechanism (e.g. Binks and Coyne 1983; Foss 1994). Better prices require those in the market to adjust their allocations, for example, buyers would switch to lower prices, and sellers would shift their sales to those bidding higher prices. Changes in the market or disequilibrium conditions are seen to cause changes in demand and supply that bring new resource deployment by economic agents and result in the difference between constellations of prices and quantities moving back to market equilibrium (Mises 1976; Samuelson 1947; Baumol 1977).

Entrepreneurship is described as a *process of co-ordinating and configuring resources* to exploit the market opportunity (e.g. Menger 1871; Penrose 1959; Barney 1991; Adizes 1996). Casson (1982) describes market co-ordination as *the* economic problem, and suggests it is the entrepreneur who is faced with difficulties in organising a market opportunity. This problem includes setting up a transaction: i.e. the buyer has to be put in contact with the seller, prices have to be negotiated, physical custody of goods has to be exchanged. Casson argues that transaction costs involve significant resource costs, with entrepreneurial success depending on minimising transaction costs that represent the opportunity costs of the market-making services that are required to overcome obstacles to trade.

Entrepreneurship is further described in terms of the *entrepreneur* - the agent that identifies market opportunities and co-ordinates and configures the necessary resources (e.g. Schumpeter 1934; Kirzner, 1973; Barney 1991; Adizes 1996). In response to the economic problem, entrepreneurs are expected to focus on combining

existing resources in a rational, profit-maximising way given prices and the neo-classical assumption is that resources are taken as given (Coase 1937).

The neo-classical view also suggests that resource co-ordination requirements include division of labor that allows for economising on dispersed information that cannot be co-ordinated by the entrepreneur alone (Foss 1994). Lack of knowledge is seen to distinguish one entrepreneur from another; making knowledge a valuable resource that can be acquired from others through division of labor that is enabled by the price mechanism (Kirzner, 1973). This division of labor also leads to the 'co-ordination problem' described earlier by Casson, that results from sharing dispersed information in pursuing a market opportunity.

Austrian school economists argue that it is the entrepreneur's *ability* to know the market, access better information or interpret differently the same information, rather than simply the price mechanism, that is a key factor affecting entrepreneurial profit (e.g. Winter 1964; Lachmann 1976; Casson 1982; Foreman-Peck 1985; Meyer and Heppard 2000). Kirzner (1973) asserts that the *learning factor* must be considered as a vital contribution by entrepreneurs to market mechanisms. He suggests that learning and experience are necessary to profit from 'entrepreneurial errors', adding that one entrepreneur's error is another's opportunity and that an entrepreneur gains knowledge from mistakes.

Casson (1990) asserts that entrepreneurs actively synthesise technical information with information about factors of production to assess potential costs and benefits. This role requires that many diverse types of information are synthesised, including technology, market preferences, factor supply, transport services, tariffs and potential restrictions on the reallocation of resources. This need to consolidate diversity of information, Casson argues, requires that the entrepreneur be a generalist, capable of assimilating a wide range of information.

Individual ability and initiative of the entrepreneur are thus considered to be a critical force in the economy and result in different outcomes to entrepreneurial activities

(Starr and MacMillan 1991; Casson 1998; Johannisson 2000). According to Johannisson (2000:379) *'what makes a difference between entrepreneurs is their varying ability to scan and select information about the environment and then interactively impose their image of reality, their vision, on the market'*.

3.3.1 Entrepreneurial Risk

A key element of entrepreneurship is the notion of *risk*, and neo-classical arguments suggest that a pre-risk activity is to assess costs of the potential venture in anticipation of future profits (Schumpeter 1934; Knight 1921; Prahalad and Bettis 1986). Casson (1982) suggests that the entrepreneur is the central character in this process that includes identifying the market opportunity, being a specialist in making judgmental decisions and being a specialised bearer of risk.

Schumpeter argues that others bear the risk rather than the entrepreneur. Schumpeter suggests that entrepreneurial judgement and risk can be a shared process that places greater emphasise on entrepreneurial behavior and activities rather than on a singular entrepreneur. Schumpeter suggests that the role of the entrepreneur is to identify and acquire commitments from others for funding and that this requires the development of a relationship between the entrepreneur and those providing risk capital to finance innovation.

Innovation for Schumpeter is a process requiring large expenditure previous to the emergence of any revenue, making credit an essential element of the process. Schumpeter claims that there is a cyclical nature of credit in financing innovation because he suggests that entrepreneurship does not occur constantly; thus risk capital for innovation will not be obtained from creditors when production combinations are unchanging. Entrepreneurship for Schumpeter involves the continual series of innovations, accompanied by rounds of new profits won, with each of them being eroded by competitors (Kirzner 1989). The profit motive and credit are thus seen together as a key process of entrepreneurship that provides, according to Schumpeter

(1934: 31) a 'regulatory principle for the unregulated business activity [of entrepreneurs]'.

Schumpeter argues that it is not unreasonable to have resistance in obtaining risk capital in the early stages when entrepreneurial innovations are new and uncertain. However, once the process of change is started and entrepreneurship spreads through the economic system, he suggests that resistance to change in financing innovation weakens and it is easier for the entrepreneur to obtain financing.

Knight (1921) in contrast to Schumpeter, views the entrepreneur as risk taker, emphasising the importance of confidence in judgement by entrepreneurs, reflected in a disposition to back up their own judgement with personal capital. Knight argues that various market factors affect entrepreneurial judgement that challenges the ability of individual entrepreneurs to manage the exploitation of opportunities for the market.

Entrepreneurship according to Knight is subjective in nature and characterised by uncertainty, resulting in a level of speculation in decision-making, a view similar to Schumpeter, who suggests that the entrepreneur needs to rely on intuition rather than on rational reasoning (Swedberg 2002). Similar to Schumpeter as well is Knight's assertion that entrepreneurial risk can be reduced through 'consolidation', the pooling of individuals best equipped to make decisions under uncertainty.

The sharing of business risk is identified by Casson (1990) as an opportunity to reduce uncertainty arising by the judgmental nature of entrepreneurial decision-making, but this sharing activity may increase the co-ordination problem mentioned earlier. Casson distinguishes between a co-ordination problem and a co-ordination process; the problem involves individual preferences, resources, the environment and the state of technical know-how, while the process is concerned with who makes each decision and how different decision-makers interact with each other. Difficulties in administration can arise in ownership and control and agreeing on the

valuation and pricing of resources. The 'co-ordination problem' is handled by various social institutions that include the enterprise, discussed in the next section.

3.3.2 Theories of the Enterprise

Enterprise creation is identified in the literature as the outcome that most uniquely distinguishes entrepreneurial behaviour and market activity (Foreman-Peck 1985; Shaver and Scott, 1991; Gartner *et al* 1992). Explanations of factors contributing to enterprise success are numerous and adopting a multi-dimensional approach to understanding the enterprise is generally accepted in the literature (Westhead *et al.*, 1993; Birley and Westhead, 1990; Storey, 1994). Certain factors of the entrepreneur, as well as of the enterprise, are seen to influence the level of new enterprise creation and performance (Miles and Snow 1978; Storey, 1994; Malecki 1997).

Various theories are forwarded to justify and explain the existence of the enterprise in the market, that include 'nexus of contract', 'institutional' and 'neo-institutional' and 'resource-based' perspectives. Nexus of contract theorists suggest that the enterprise is a response to counter the 'co-ordination problem' associated with separate production functions or division of labor (Casson 1982; Langlois 1991; Jensen and Meckling 1992). Contractual arrangements are seen to minimise the incentive problems arising when separate production functions require identifying, measuring and monitoring, often the case with manufacturing industries (e.g. Coase 1960; Alchian and Demsetz 1972; Jensen and Meckling 1976).

Institutional theory is based on earlier work by Coase (1937) that supports the creation and existence of the enterprise as a rational and necessary substitute for markets when the transaction costs of using markets becomes large relative to the costs of managing markets. The enterprise is seen as a market mechanism that minimises management transaction costs such as team production relative to the market (Alchian and Demsetz 1972) and minimises costs of co-ordinating the movement of goods and services relative to property rights costs through the price

mechanism (Williamson 1991). The enterprise is also seen as a mechanism to minimise transaction costs through rational allocation of resources to their most highly valued uses (Demsetz 1988).

Neo-institutional theory broadens the institutional theory focus on the enterprise as a market institution to acknowledge the role and power of social institutions in general in the market (Langlois 1986). The basis of neo-institutional theory derives from generalised neo-classical property rights theory and conceptualises the economy as a dynamic process, where entrepreneurial gain exists for agents who adopt institutions that economise on the costs of information and transaction (Foss 1994). Neo-institutional theorists also suggest that institutions are themselves potential objects for economic explanation because specific rules, norms and activities may enable and constrain economic activity (Langlois 1986).

Literature suggests that the role and rules of certain types of institutions, such as credit institutions, have a significant effect on the level of entrepreneurial activity in the economy (Schumpeter 1934; Evans and Jovanovic 1989; Blanchflower and Oswald 1991; Baumol 1990). Entrepreneurs apply for credit according to their prospective profit and this is conditioned by monetary and credit policies of credit institutions.

As Evans and Jovanovic (1989) forward, liquidity constraints of the entrepreneur allow credit institutions to ask for and receive collateral that engages the entrepreneur in bearing risk. The credit institution creates collateral requirement for loans to avoid problems of moral hazard and adverse selection among entrepreneurs resulting from asymmetric information between the lender and the entrepreneur (Blanchflower and Oswald 1991). Schumpeter in fact suggests that the entrepreneur and the enterprise have a function that must be considered jointly with that of the credit institution.

3.3.3 Resource-based Theories

Resource-based theory, credited to Penrose (1959), describes the enterprise as a collection of physical and human resources that are co-ordinated by an administrative organisation. Resources are described as tangibles (financial capital, products, information systems) and intangibles (human skills, knowledge, brand power) (Amit and Schoemaker 1993; Chandler and Hanks 1994; Dean *et al* 1998). Advancement beyond the new enterprise stage requires the enterprise to become proficient at identifying and developing products and markets, as well as integrating resources, operationalising systems and managing an organisational culture (Framholtz 1995).

The term 'capabilities' has been incorporated into resource-based theory. The distinction between capabilities and resources is noted by Amit and Schoemaker (1993), who define *resources* as the stock of available factors owned or controlled by the enterprise, and *capabilities* as a firm capacity to deploy resources, usually in combination, using organisational processes. Capabilities are expected to develop over time as a function of the resource base of the firm and as a function of the activities it undertakes to fulfil its mission. Both resources and capabilities may be continuously evolving both in anticipation of and in reaction to changes in the business environment.

Katz and Gartner (1988) suggest a mix of properties (intentionality, resources, exchange, and boundaries) that they consider as both necessary and sufficient to constitute a new enterprise. Intentionality appears as entrepreneurs begin to seek information that could be applied toward achieving the goal of founding a new enterprise. During this time, entrepreneurs begin to engage in cycles of social exchange to secure the use of resources such as information, property, capital, and credit. At some point, boundaries are established (full-time employees are hired, office space is occupied, etc.) and business operations are commenced.

3.3.4 Growth Theories

Previous theories – e.g. nexus of contract, institutional and neo-institutional and resource-based – discussed *why* the enterprise is identified as the primary and appropriate market mechanism to co-ordinate resources and exploit a market opportunity. This section now discusses models and related theories that describe *how* the enterprise is formed, evolves and develops.

A large body of literature describes the enterprise in terms of a sequence of stages for growth through which each enterprise develops (e.g. Greiner 1972; Kroeger 1972; Churchill and Lewis 1983; Mount *et al* 1993). Some of these growth models are based on the ‘linear’ product lifecycle model, beginning with birth or start-up, initial development and through to growth, maturity and decline. Other growth models have considered technological innovation, management evolution and financing stages (Timmons 1999).

Figure 3.1 synthesises contributions from the literature on stages of enterprise growth. In general, growth models seek to offer predictions on how enterprises develop by providing research insights into the factors affecting the successful transition of the enterprise from one stage to the next. These models describe the state of the enterprise according to a number of its attributes: the product and market state, the focus of the entrepreneur and management and competencies required, the organisational structure as well as the cash flow and funding requirements.

The first phase of enterprise growth is described as the *inception or start-up phase* and is characterised by testing or proving the idea or innovation as a viable business strategy. Here, the entrepreneur must qualify the market potential before commitment of resources and then outline the resource requirements in terms of the technology, production, marketing, financial management and leadership skills Bygrave (1997).

Figure 3.1: Synthesis of Growth Theories of Enterprise

(Greiner 1972; Kroeger 1972; Churchill and Lewis 1983;
Mount, Zinger and Forsyth 1993; Bhidé 2000)

Stage	Management Focus	Enterprise Structure	Financing	Intellectual Property
Start-up/ Inception/ Initiation	Innovation and design	Informal	Self-financing, public grants, limited private funding	None – build intellectual property (IP)
Survival/ Development	Planning, selling business plan	Hierarchical	Business angels, some venture capital	Build and protect
Growth	Sales, marketing and cash flow	Bottom-up, delegation	Venture capital	Protect and harvest
Maturity/ Expansion	Cost control and operations	Function, strategic business units	IPO	Harvest and build new IP
Decline/ Innovation	Organisational innovation	Matrix; collaboration – conflict	Harvest strategy or investment in innovation	Lose IP or build new IP

Mount *et al* (1993) state that this phase is dependent on the founder's technical skills rather than general management skills. Kroeger (1974) cites technological development as the primary functional emphasis in start-up and suggest a possible 'exit-revert' option at this phase should the launch of the enterprise be unsuccessful. For Bhidé (2000) success in this early stage of the venture depends on an individual's capacity for 'opportunistic adaptation' that reinforces the need for flexibility and entrepreneurial inspiration to inspire others to invest in the venture. Timmons (1999) suggests that new ventures spend two to three years in the start-up phase.

The second phase is described as the *development or survival phase* and is characterised by first sales and increasing sales volumes that require the founder to empower other employees, and the creation of a simple but more formal hierarchical management structure. Bhidé (1996) claims that many enterprises during this time fail to attract critical skills from the outside and perform most of the crucial tasks themselves. Kroeger (1972) suggests that key managerial qualities during this phase are associated with financial planning.

The third phase is described as the *growth phase* and is characterised by substantial increases in sales and turnover. Cash flow problems are seen as the most common reason for enterprise failure, often because of the time lag between the costs of production and payment receipt. Further external investment is commonly associated with the introduction of changes to management and future strategy, particularly if venture capital is introduced.

During the growth phase, Greiner (1972) suggests that successful ventures must move away from a hierarchical structure and authority and delegate to lower levels. However, de Vries (1985) suggests that entrepreneurs have a preoccupation for control and find it difficult to delegate authority while Mount *et al* (1993) argue that the need to delegate more of the decision making powers to subordinates may be difficult for enterprises with a strong central locus of control.

Organisations that survive the crucial growth stage, Kroeger suggests, need to create internal stability in order to maintain their new market positions, resulting in the creation of new layers of management and specialist business functions. Kroeger emphasises co-ordination and interpersonal relations as key managerial skills.

The fourth stage is described as *maturity* and is characterised by an enterprise attempting to reduce costs as sales growth tapers off. During this time, the enterprise is likely to have achieved minimum efficient scale (MES), acquired greater access to internal or external sources of financing or demonstrated an ability to innovate. Timmons (1999) suggests that successful ventures will experience the maturity stage ten years after start-up and that the key issue is no longer survival but one of steady and profitable growth.

A common strategy is to achieve economies of scale, whereby the enterprise's greater output achieves lower average costs and allows the enterprise to charge lower prices. As average costs fall with greater output, the MES and optimal firm size increases. Related to this strategy is the attempt to build up barriers to entry that can significantly increase profits.

The final stage of growth reflects the industry in *decline* and the need for innovation. This stage is characterised by competitors squeezing margins and market share, and unless the enterprise can find new and innovative products or processes to enhance their revenues, it will enter a decline phase. According to Day (1997), the enterprise should be aware of early warning signals for decline that include entry rates and the amount of excess capacity in the industry.

Reich (1987: 80) suggests that continuous innovation at this stage can capture changing market opportunities. Reid states that innovation can be attained through a number of ways: stripping out middle level managers, profit sharing, encouraging greater communication and co-ordination and refinement of a variety of ideas.

3.3.4.1 Further Descriptions of Enterprise Growth

For many of these growth models, the entrepreneur is a central figure that can both enable and constrain enterprise development and growth. De Vries (1985) refers to the 'dark side of entrepreneurship' by noting "*an entrepreneur's attention to detail that is such a virtue in the start-up phase can be truly crippling if he or she continues to exert such control when the organisation grows*".

Earlier research by Miles and Snow (1978) suggest strategies to create and grow the new enterprise are often determined by an *entrepreneurial spirit* deriving from personal traits and characteristics, and claim that individual personalities, their antecedents and consequent attitudes and motivations play an important role within the organisational structure.

Bhide (1996) emphasises the central role of the entrepreneur in persuading other staff to accept the transitions in enterprise evolution but acknowledges that many enterprises do not evolve smoothly or steadily through each phase of growth, stating that "ventures evolve in unpredictable, idiosyncratic ways that do not conform to one-size fits all models of development (Bhide (2000: 245). He argues that growth

models do not account for the fact that enterprises vary in progressing through evolutionary stages and may in fact skip stages.

Rather than describing a stage model of growth, Bhidé (1996) compares the critical issues of three possible firm statuses (promising start-up, fledgling or transitional firms, and large corporations). Bhidé identifies a gap between start-ups and more mature firms in terms of assets, co-ordination mechanisms and capacity for growth. In order to bridge this gap, the entrepreneur must formulate and implement a longer term strategy rather than relying on what Bhidé terms 'opportunistic adaptation'.

In Bhidé's view, entrepreneurs must perform three 'critical tasks': the articulation of purpose and goals, the formation of strategy, and the implementation of the previous tasks. Entrepreneurs must also possess some 'exceptional qualities' related to these tasks, such as the ambition in setting purpose and goals or the ability to envision the firm's future in strategy formation. The level of entrepreneurial skill and managerial competence is considered crucial to success and needs to evolve with the firm (Bhidé 2000).

Bhidé argues that entrepreneurs should develop their skills and competencies to strategic levels and evolve themselves *if* they want to grow. He states that *"entrepreneurs who aspire to operate small enterprises...never have to change their roles...transforming a fledgling enterprise into an entity capable of an independent existence, however, requires founders to undertake new roles"* (Bhidé 1996: 120). Similarly, Timmons (1999) suggests that the key to achieving longer-term sustained growth is the entrepreneur's ability to possess or develop competencies as an entrepreneurial manager.

Churchill and Lewis (1983) suggest enterprise growth is a response to the dynamics of the business that is strongly influenced by entrepreneurial behaviour and actions. At each of their five stages, the factors necessary for growth must be balanced with the abilities of the entrepreneur. For example, the entrepreneur's ability to innovate and sell the product is vital in the enterprise's early stages, but as the enterprise

grows, managerial skills and delegation of growing responsibilities are more important factors for the entrepreneur. They suggest that the entrepreneur's failure to acknowledge skill limitations is a major reason why many enterprises fail at the success phase.

An earlier enterprise growth model by Greiner (1972) establishes five phases of growth (creativity, direction, delegation, co-ordination and collaboration) that are punctuated by explicitly defined crises that include issues of leadership, control, red tape and other managerial problems. For the enterprise to make the transition to the next phase, Greiner argues that obtaining additional resources – financial, expertise, control systems, for example – will challenge autonomy and control of the entrepreneur. The main point of Greiner's approach is that it is unlikely that the entrepreneur or creator will have the necessary resources or skills to develop the enterprise through the later phases of growth. Greiner believes that enterprise growth occurs as a result of the response to these crises.

Kroege (1974) suggests, similar to Greiner, that as the enterprise grows, its founders are forced to perform roles that may be beyond their abilities and require additional resource acquisition. However, Kroege's model provides the notion that not all enterprises will *willingly* grow. He suggests that as the enterprise is faced with growth challenges, the entrepreneur or founder might make the decision to remain at the current position, take steps to grow the enterprise or exit the business. Kroege believes that if enterprises perform satisfactorily at each phase they will progress to the next phase of the model.

Mount *et al* (1993) place more emphasis on external factors and the organisational complexity that occurs as the enterprise grows that places an increased demand on managerial and financial resources. Growth, or the transition to the next phase, they suggest, is a response to a combination of both internal forces that include the goals of management, and environmental forces such as industry turbulence, competition or technological change. Increasing organisational complexity and possible enterprise instability makes it susceptible to internal operational crises in addition to

formidable competitors. Mount *et al* conclude that enterprise growth will occur through creativity, direction, delegation, co-ordination and collaboration respectively provided by the entrepreneur or management team.

Growth models tend to focus on the internal environment within the enterprise, with the notable exception of Mount *et al* (1993) who stress the importance of continual assessment of the operating environment and the enterprise's position. Mount *et al* also acknowledge barriers to success such as financing, lack of resources, unwillingness to delegate or share responsibility and unfavourable economic conditions.

Day (1997) argues that enterprise success is not merely a reflection of the appropriate internal management of the enterprise but is related to the influence of external factors and the firm's ability to react. Day suggests key external factors that include sources of funding, the macroeconomic environment, political environment, market competition, firm location and the possibility of boom and bust.

The type of financial structure is identified as a key variable in enterprise start-up and growth that challenges the sequential stages of growth models. Shulman (1997) argues that venture capital will often have implications in how the business is managed. Venture capitalists often invest their financial *and* managerial expertise as well as their capital to ensure required returns will be realised. Davis and Stetson (1984) found that new ventures receiving venture capital funding had significantly higher rates of success than those ventures that received funding from other sources. The difference was attributed to the industry expertise and managerial competency that venture capitalists brought to fledgling companies.

At the same time, Sapienza and Timmons (1989: 74) suggest that management know-how and competencies are key to company establishment and that new management skills are necessary as shifting and new objectives occur during the evolution of the company. They state that "*effective company building is much more than just a matter of providing money to fund research for a new innovation or to*

pounce on a new opportunity". They further suggest that lack of the necessary management skills and networks at critical times in the company's life cycle is a key factor in limiting the rate at which the company grows.

Determination of a market entry strategy is a considerable challenge for new enterprises, according to Bygrave (1997:61), as entrepreneurs must identify *where* a new product will fit into the market, as this will dictate *how* to enter the market. Bygrave states, "*what it takes to start a company around a new product or service includes, most importantly, the discovery of an intersection between the market for that product or service and a way to create one*". He stresses that, given limited resources and competitive strengths, the innovator or entrepreneur must focus on customers most likely to buy the innovation first and establish an early cash flow for the company.

Indeed, Bhidé (1994) argues that a low risk entry strategy for the entrepreneur includes a venture with low capital requirements, high margins for errors, simple operations and low fixed costs, significant payoffs, low exit rates and option to cash in by selling all or part of the equity. Intellectual property is also acknowledged as a key asset from which to form a new enterprise, as the right to such property is a powerful barrier to entry.

3.4. SOCIAL PERSPECTIVES

Entrepreneurial actions and the creation of enterprise, it is suggested, cannot be interpreted without understanding entrepreneurial motivations and action within a social context (Burt 1988; Parson 1990). Johannisson (1993) suggests that the enterprise should be viewed as an integration of individual variables along with independent variables (resources, capabilities and external environment) because entrepreneurial capabilities may only partially reflect components of the entrepreneurial process involved in an emerging enterprise.

Social theories forward that certain variables of entrepreneurial behavior and activities affecting economic development are not accounted for in neo-classical economics (Burt 1988; Collins 1990; Parker and Stead 1991; Bowles 1998). In an attempt to address the economic significance of the entrepreneurial role, sociological theorists argue that individual and social-structural variables provide part of the explanation to the residual part of the aggregate production not explained by rates of growth of inputs² (Samuelson 1983; Zafirovski 1999).

Sociological theory takes the position that entrepreneurial actions, in the same way as behaviour, involve processes that are intertwined with structures of social relations. The social structure of the market contains networks of individuals and institutions that result in entrepreneurship being affected by 'institutionalised motivation' and subject to institutional variation. These include historically specific systems of meanings and other cultural patterns and broad social and political factors that can influence actions (Zelizer 1996).

Max Weber's contributions to entrepreneurship include societal attitudes to the role of the entrepreneur, particularly attitudes toward moneymaking and commerce. Weber argues that once a society's attitude towards entrepreneurship becomes positive, the 'vocation to make money' is set free (Weber 1968).

In line with Weber's work, Lipset (1990) argues that societal values characterised by various social institutions deeply affect entrepreneurship and the level of economic development. Lipset stresses that social structure conditions make economic development possible, and poses the question of whether one is involved in a network of social relations that sustain or negate a particular activity. In comparing two socially different regions - Latin America with North America - Lipset found that success based on fortune in business, an emphasis on science and engineering education and values that emphasise work and moneymaking in North America contrast Latin American success based on landed property, an emphasis on humanist

² Other variables, such as investment-specific technological change and 'imponderables' such as fortune or misfortune, punctuality or error, aggressiveness or indolence, among others (Zafirovski 1999) are seen to account for residual production growth.

education and values that downgrade manual labour as well as commerce and industry.

At the same time, social theory does not negate the importance of the singular entrepreneur. Starr and MacMillan (1991) found that variations in entrepreneurial emotions and social values affect behaviour and consequently result in different outcomes to entrepreneurial activities. They suggest that individual initiative of the entrepreneur is a critical force in the economy as a whole; therefore, understanding the characteristics and behaviour of the individuals taking initiatives is necessary.

Entrepreneurial success has been identified with entrepreneurs that have simultaneous involvement in a number of ventures and sequential or habitual entrepreneurs founding a number of businesses over time (MacMillan and Katz 1992; Birley and Westhead 1990). Literature on knowledge transfer from previous employment shows that the new enterprise often serves the same market or uses the same technology as the organisations that the entrepreneur left (Cooper, 1985; Freeman 1982).

Johannisson (2000) argues that even entrepreneurs who can intellectually grasp opportunities have to restrict their field of action because of limited resources and time to nurture a personal network that can provide additional resources being sought. Johannisson suggests that an 'organising context' is required by the entrepreneur to cope with ambiguity. This organising context can be used to launch new enterprises according to opportunity and to demobilise resources tied to obsolete ventures and to reallocate them to new emerging ventures. This organising context provides the functions required for successful venturing; creating legitimacy, resourcing inputs, and business intelligence. The organising context created by the entrepreneur is in contrast to the concept of the 'task' environment, in which the entrepreneur exercises little control.

3.5 EXTERNAL FACTORS OF ENTREPRENEURSHIP

Opportunities for innovation and entrepreneurship, according to neo-classical theory, are affected by 'push'³ and pull' factors⁴ (Karlsson *et al* 1993). Low entry barriers to a particular industry sector are seen to attract an increased supply of entrepreneurs and enterprises, and the presence of a large number of small enterprises in an industry may be *a priori* evidence that barriers to entry are low and/or that the optimum size of enterprise is small (Foreman-Peck 1985). Westhead (1991) found that low entry barriers attract imitative rather than innovative entrepreneurs.

Casson (1998) argues that conditions in the marketplace influence opportunities for market entry, how the enterprise is formed and its speed of development with each industry sector influencing considerable heterogeneity in how enterprises' develop. He asserts that enterprises also pursue independent paths as a result of different entrepreneurs forming different judgements about price, quality, output, investment based on dispersed sources of information.

The ability of entrepreneurs to acquire and manage resources in growth transitions is moderated by the type of industry and relative strength of industry characteristics such as growth rate, competitiveness and technological development (e.g. Eisenhardt and Schoonhoven, 1990; Dean *et al*, 1998). Research by Robinson and McDougall (1998) found industry characteristics, such as industry life cycle, industry concentration and product differentiation, all produced quite different influences on growth of a sample of 'high-potential' manufacturing ventures.

³ *Push factors* involve creating a new market by introducing a new product. Audretsch (1993) found that in traditional industries, such as manufacturing, there is little support for the push thesis, arguing that new opportunities are related to conventional economic theory, with market entry in response to an increase in anticipated profitability.

⁴ *Pull factors* reflect the increased demand for new goods and services and characterise favourable market conditions and post-entry profitability (Foreman-Peck 1985; Karlsson *et al* 1993). Pull opportunities are also influenced income or wealth of customers, the location of the enterprise, the size of the market, the tax system and exit rate of enterprises in that industry or sector (Binks and Coyne 1983; Foreman-Peck 1985). Karlsson *et al* (1993) suggest that the availability of local resources and managerial skills affect the ability to pursue entrepreneurial opportunities, and note that the creation of subsidiaries from large firms or the spinning-out of new firms from existing firms is an indication that favourable market conditions exist.

Problems of resource management are identified from contributions to resource-based theory from the life-cycle model of enterprise growth that suggests that enterprises, like biological organisms, grow over time, increasing in size and complexity (Aldrich, 1990). In this model, the enterprise is able to grow with existing resources until the next stage of growth requires more resources, with ongoing enterprise restructuring often necessary during periods of rapid growth. Hannan and Freeman (1984) add that market factors that are subject to unpredictable and continuous change can create constraints in some resources and slack in others.

Penrose (1959) claims that ever-changing conditions make configuration of resources for long-term gain especially difficult for entrepreneurs. One problem is the growing value and stock of resources that must be managed. The size, complexity and value of the resource bundle growing over time, where value is measured by the ability of the resources to generate economic rents.

Determining the style and management structure best suited to the environment is seen as a key challenge for the new enterprise. Birley (1990) states that the growth and development of entrepreneurial companies can be viewed in terms of how quickly entrepreneur, management, organisation and ownership can adapt and learn from the experiences in the combination of internal and external environments. Birley notes that management is responsible for recognising the need for change, and as the capability of the enterprise changes, necessary resources will be often be required from outside the enterprise.

Birley and Stockley (2000) argue that managing growth and complexity can be understood by operational research that includes 'Ashby's law' of requisite variety. This law forwards that the variety (complexity) faced by an organisation or system can only be controlled by a system (e.g. management) of at least equivalent variety. Birley and Stockley suggest that greater complexity inherent in a high growth enterprise may be better managed by an entrepreneurial team.

The existing level of innovation in an industry has been found to affect new enterprise formation with opportunities for formation high in industry sectors where small-firm innovation is high relative to that of large firms (Acs and Audretsch 1989). Similarly, research has established that where large-scale economies exist and where capital intensity and innovation rates are greatest, new enterprise formation will be relatively less frequent (Audretsch 1993).

Audretsch (1995b) has found that industry-specific factors determined more variety in survival rates across sectors than in entry rates, suggesting that the ability of a venture to maintain competitive advantage is a greater challenge than recognising the profit opportunity in the first place. Audretsch points out the lack of consideration for the effects of rates of innovation, economies of scale and start-up size on survival rates across different business sectors. Audretsch argues that survival rates are lower in those industries characterised by a high level of minimum efficient scale (MES) and innovation. In such industries, Audretsch found that those firms that succeeded in surviving gained the MES or ability to innovate as required by the market and therefore showed high rates of growth.

In each industry sector, Audretsch (1995b) points out that 'business shakeouts' can occur either through an oversupply of enterprises providing the same product or a change in MES. In economic down-turns as an example, enterprises would want to reconsider any growth strategy and attempt to reduce costs to survive. Another factor could be deregulation that provides the opportunity for growth by buying out competitors or forming alliances or joint ventures.

Government statistics lend support to Audretsch's business shakeout theory, showing the pattern of failure rates of businesses that have survived the start-up process itself. According to the UK's Department of Trade and Industry (DTI), approximately 90 percent of all start-up businesses survive their first year, but less than two thirds make it past their third year based on 1998 data. In the US, the federal government's Small Business Data Base estimates that 60% of start-ups fail in the first six years

and over 70% in the first eight years. As well, it suggested that most of the start-ups that survive remain small (Storey 1994; Bhide 2000).

3.6 SUMMARY

This chapter has identified the importance of entrepreneurship as a process in the exploitation of previously unidentified market opportunities and the introduction of new innovations into the market. Key elements of entrepreneurship are suggested – searching and identifying market opportunities, co-ordination of resources and acceptance of risk. Schumpeter's description of the entrepreneur is as 'market innovator' in the creation of new markets and the disruption of existing ones by doing things different.

Successful exploitation of market opportunities is credited to the superior judgement of entrepreneurs or others involved in risk sharing. Literature suggests that 'collective entrepreneurship' allows for the sharing of exploitation risk and acknowledges the diversity of exploitation requirements that distinguishes between the role of the entrepreneur and manager.

Neo-classical theories suggest that exploitation of market opportunities is most economical through the creation of the firm or enterprise. Growth models, based on the product life-cycle concept, suggest that as an enterprise exploits profit opportunities and grows, there is a need for transition from one phase to another. In general terms, five phases are suggested: start-up, development, growth, maturity and decline. Growth models suggest that changing management needs are required through different phases. The addition of specialist resources as the enterprise increases in size, complexity and experiences competitive pressures are seen to challenge the early-stage skills of the entrepreneur in the requirement for more formal professional skills and management.

Similar to the previous chapter on innovation development and exploitation, this chapter emphasises the need to consider entrepreneurship within a socio-economic framework. Economic arguments emphasise the market conditions, industry lifecycles, and scale economies as key factors determining the potential success of new enterprises. Social theories emphasise broader social and political factors, societal attitudes to entrepreneurship and market structures that influence interactions among individuals and institutions in creating and supporting entrepreneurial activity and enterprise creation.

Implications from this literature to the research intent of the thesis identify first of all the importance of entrepreneurial capabilities – traits, knowledge and actions – in identifying market opportunities or introducing innovations into the market. This suggests the need to incorporate and account for entrepreneurial activity in the exploitation process that will most likely be distinct from technical or public supportive agents and more evident in the case of exploiting the innovation through the creation of a new enterprise.

Second, in identifying the enterprise as an exploitation mechanism that evolves through various growth stages, collective actions can be identified by examining the interactions between the enterprise as unit of analysis and the regional socio-economic context that directly interacts in support of the enterprise over time. Indeed, for the purposes of the thesis, this socio-economic context will be delineated as the regional support network whereby support agents can be identified and their activities examined as they relate to supporting these enterprises attempting to exploit technology-based innovations.

CHAPTER FOUR

NETWORKS: THEORIES AND PERSPECTIVES

4.1 INTRODUCTION

This chapter begins with theories, definitions, characteristics and dimensions of networks and discusses the importance of networks for entrepreneurs and new enterprises. The chapter looks at network processes that lead to interactions and exchange of tangible resources and capabilities, such as knowledge, investment and human resources and intangibles such as trust, relationships and learning that are critical formative elements of the new enterprise.

The chapter then discusses the role of network intermediation, research on networks and suggested methodological difficulties in network evaluation.

4.2 DEFINITIONS

Multiple definitions have arisen to accommodate various types of networks and their characteristics, dimensions and functions. At one level, networks are defined according to actors and their interactions with one another. For example, an *innovation network* is defined as a loose-knit group of knowledge intensive firms and other organisations that contribute to the development of new products and services (Blundall and Smith 2001). A *business network* is described as '*an integrated and co-ordinated set of ongoing economic and non-economic relations embedded within, among and outside business firms*' (Yeung 1994: 476).

Ebers (1997) on the other hand, suggests that all networks are characterised by recurring exchange relationships among a limited number of organisations that retain residual control of their individual resources yet periodically jointly decide over their use.

The economic sociologist Granovetter (1973, 1985, 1995) argues that *social networks* are a key determinant of economic action, which he defines as action that is oriented toward the allocation of scarce resources to alternative uses. Granovetter's premise is that economic agents are embedded in concrete, ongoing systems of social relations, and these relations facilitate and constrain agent's profits and rent seeking activities. He suggests that an economic agent is affected by the level of *social capital* available, defining social capital as the relationships and assets available in the network and characterised by structural and relational 'embeddedness' dimensions that will be discussed later in the chapter.

Theories of social capital (Granovetter 1995; Burt 1992) argue that people invest in social opportunities from which they expect to gain or profit. Williamson (1985) suggests social investment is considered in terms of transaction cost economics where social activities are motivated by entrepreneurs and enterprises attempting to minimise communication, information search and other costs associated with seeking resources, capabilities and customers. On the other hand, Zajac and Olsen (1993: 137) argue that transactions involve a 'joint value maximisation principle' whereby the focus is on exchange partners and the emphasis on collective value.

Best (1990) suggests that networks are preferable to markets because they involve more social contact and encourage information to be shared, they are more co-operative and less competitive and they reinforce the sense of mutual obligation on which society depends.

Of particular interest for this thesis are perspectives discussing individual and organisational interdependencies in supporting technology exploitation and enterprise creation that draw on theories and perspective that describe the social structures of networks and social processes within these networks.

4.2.1 Entrepreneurial Networks

Entrepreneurial network theory suggests that social relationships influence the entrepreneur’s ability to acquire resources and that these resources play a key role in founding new enterprises (e.g. Birley 1985; Starr and Macmillan 1990; Dubini and Aldrich 1991; Butler and Hansen 1991; Larson and Starr 1993; Birley and Stockley 2000; Johannisson 2000). These resources include financial, human and social capital.

Entrepreneurial network theory also identifies the importance of the networking function, and Figure 4.1 shows Johannisson’s interpretation of the functions of entrepreneurial networking and the potential effects on the entrepreneur and the enterprise. Johannisson describes the creation of a new enterprise by an entrepreneur as the “*institutionalisation of a part of the entrepreneur’s personal network into a venture, subsequently confirmed as a legal construct*” (Johannisson (2000:373). The entrepreneur uses their network as a generic tool for attracting financial, human and social capital into the new enterprise.

Figure 4.1: Functions of Entrepreneurial Networking
Adapted from Johannisson (2000)

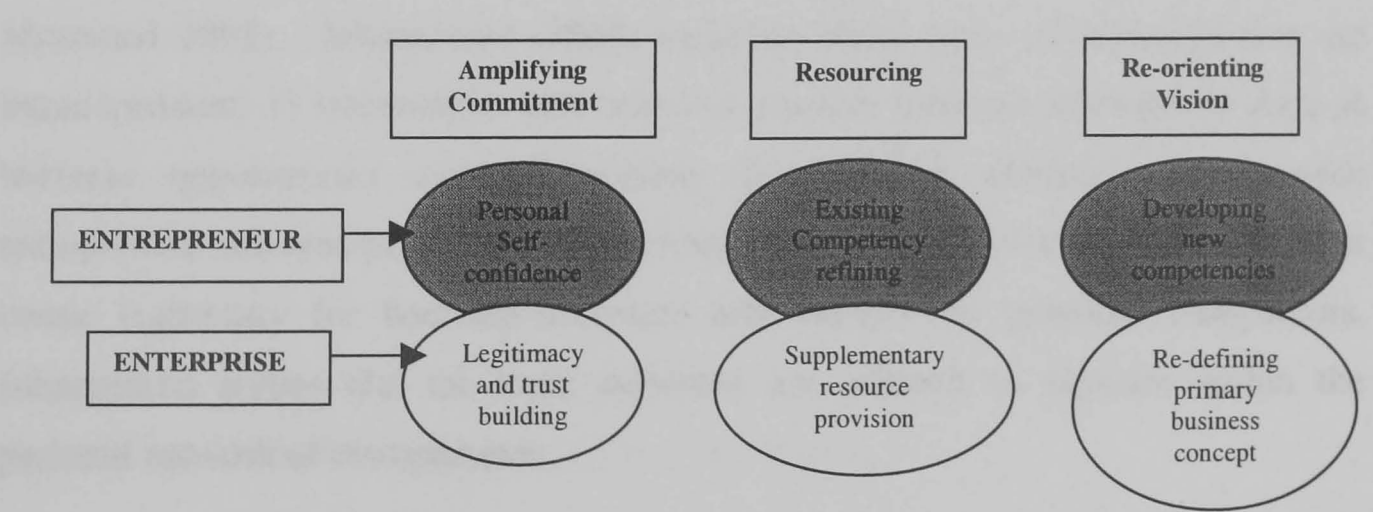


Figure 4.1 identifies the relationship between entrepreneurial activities and their effects on the enterprise. Johannisson describes the entrepreneur as the main actor that brings the resources from different actors and institutions together with personal financial resources, their personal skills, and their social resources.

Figure 4.1 refers to 'entrepreneurial abilities' that differentiate entrepreneurs in how they identify, cultivate and manage a network partnership, their willingness to attract and recruit people who know the industry, and the commercial outcomes of these efforts (e.g. Pfeffer and Salancik 1978; Starr and MacMillan 1990; Vesper 1990; Sharman *et al* 1991; Cooper and Folta 2000). Legitimacy is seen as a necessary hurdle for a new enterprise to overcome in order to access resources and assets from others and networks can contribute positively to gaining legitimacy and to developing a desirable marketplace reputation.

The abilities of the entrepreneur as a 'networker' has been studied through the processes used by entrepreneurs in creating and managing a network (e.g. Birley 1985; Aldrich and Zimmer 1986; Aldrich *et al* 1987; Venkataraman 1989; Dubini and Aldrich 1991; Larson 1991; Larson and Starr 1993). Entrepreneurs identify product or service ideas, access to markets, information, cash and other resources in their environments, and they gain access to these resources through exchange transactions with various members of their social networks. This process has been called resource co-optation through social contracting (Starr and MacMillan, 1990).

Entrepreneurial behaviours and actions are also described in the context of processes and structures of different *networks* that are being engaged (e.g. Johannisson (1995; Moensted 1995). Johannisson (2000) identifies three types of networks that are interdependent: 1) information networks that provide business intelligence such as business opportunities and information; 2) exchange networks that provide entrepreneur and enterprise with needed resources; and 3) networks of influence that create legitimacy for bounded activities and barriers for potential competitors. Johannisson argues that the three networks are difficult to separate within the personal network of entrepreneurs.

Monsted (1993) distinguishes between three types of networks, with each serving a different function for the entrepreneur: 1) networks for service and assistance; 2) networks for information and structuring, particularly for knowledge about whom to

contact for a specific purpose; and 3) networks for entrepreneurship and product development.

Sanberg and Logan (1998) suggest that an entrepreneur's network really comprises *multiple networks* as they are defined by the resources each network provides. They further argue that the entrepreneur who fails to make this distinction, directing energies toward developing an undifferentiated network, is less likely to acquire critical resources than is one who targets their most effective sources. One question they propose is not whether networks are required for co-ordination, but under what conditions they work best.

The *personal network* of the entrepreneur is identified as a main resource for creating new enterprises with personal networks encompassing both business and social relationships (Birley 1985; Johannisson 1988, 1996; Larson 1991; Aldirch *et al*, 1989). Birley (1985) asserts that entrepreneurs in the early stages of enterprise formation rely heavily on an informal network of local social contacts that include family, friends and acquaintances.

Birley *et al* (1991) postulate that in later stages, the entrepreneur relies on formal networks of professional service providers – accountants, financial intermediaries and lawyers – as well as government organisations that provide access to relevant business resources and information. However, their cross-sector research did not demonstrate that older enterprises relied more heavily on business contacts versus social contacts.

4.2.2 Network Structures and Evolution

Networks are also described as social structures that are defined according to various dimensions. Network *size* is defined as the number of direct ties involving individual units, and the term *structural embeddedness* is used in referring to the overall structure of network relations that includes number of individuals and the density of

social ties between these individuals. (Burt 1983). Studies suggest network size is positively related to a higher birth-rate of new companies and initial performance (Burt, 1992; Johannisson, 1986; Nohria, 1992). However, Reese and Aldrich (1995) found no evidence to support the effect of network size on enterprise survival. Aldrich *et al* (1987) found that network *density* was associated with new enterprise profitability, while network *accessibility* was positively correlated with enterprise founding.

Mixed empirical research results on structural embeddedness and its effects on enterprise performance lead to perspectives focused on social networks and their effect on the processes of founding new enterprises. The more appropriate measure of a network may be the size of the 'subset of people' who are somehow involved with the entrepreneurs in founding the new organisations.

Sub-sets of people have been described as *action sets* that are characterised by the shared intentionality of those involved in founding a new enterprise (Katz & Gartner 1988). Thus, when entrepreneurs decide to act in order to achieve the goal of founding a new organisation; and they activate an appropriate subset of their total network (and each activated member in turn activates his or her own appropriate subset, and so on, until the goal is either achieved or abandoned); the group of people involved in attaining the goal is called an entrepreneurial action set. Katz and Gartner (1988) and Hansen and Wortman (1989) have called these groups *pre-organisations*. The entrepreneurial network literature generally associates their size with initial new organisation performance.

Another network dimension - *relational embeddedness* - refers to the extent to which economic actions are affected by the quality of actors' personal relations (Granovetter 1995). In contrast to structural embeddedness, Granovetter suggests that relational embeddedness have more direct effects on economic actions and outcomes. Personal relations have been described as a set of nodes linked via a set of concrete personal relationships of a specified type (e.g., friendship, overlapping membership) that can influence the efficiency of economic actions.

Most network stakeholders will bring to the network a history of business transaction relationships and associated expectations with regard to future business transactions, referred to by Berger *et al* (1995) as ‘*temporal embeddedness*’. As individual or institutional interests are presented and the potential for mutual exchange explored, stakeholders cannot help but consider the costs and benefits of exchange. The logic of collective benefits does not preclude those motivated by self-interest who do not invest resources in mutual gain. The *free rider* phenomenon may occur from a conscious decision not to contribute or the lack of resources to exchange (Olson 1965).

The importance of *strong ties* between those seeking resources and those providing resources is noted by Burt (1992: 272), who states “*a person with a poorly structured network that includes just one well-placed contact can do well through that contact’s sponsorship regardless of how well the person’s network as a whole is structured*”. According to Uzzi (1997) strong ties within the network can enhance enterprise performance directly through trust building, information transfer and joint problem solving arrangements. A related concept is ‘cognitive legitimacy’ that allows the actor, in creating solid partnerships, to overcome legitimacy barriers (Aldrich and Fiol 1994).

At the same time, *weak ties* are seen to also enhance enterprise performance, according to Burt (1992), who suggests the vaguely defined network relationships provide the freedom for entrepreneurs to act upon opportunities without being bound by obligations and expectations. Similarly, Granovetter (1985) suggests that information obtained from weak ties is more likely to be unique and less likely to be redundant. This *diversity of information* from weak ties is used to explain the introduction of innovations into organisations.

The economic argument for networks identifies *resource embeddedness* as a dimension of social capital, with the network as a ‘mechanism’ to leverage resources from their owners. Casson (1997) suggests that economic rationalisation leads to the notion of the cost and benefit of network engagement and exchange that will be

affected by the resource needs of the entrepreneur and enterprise at a given point in time.

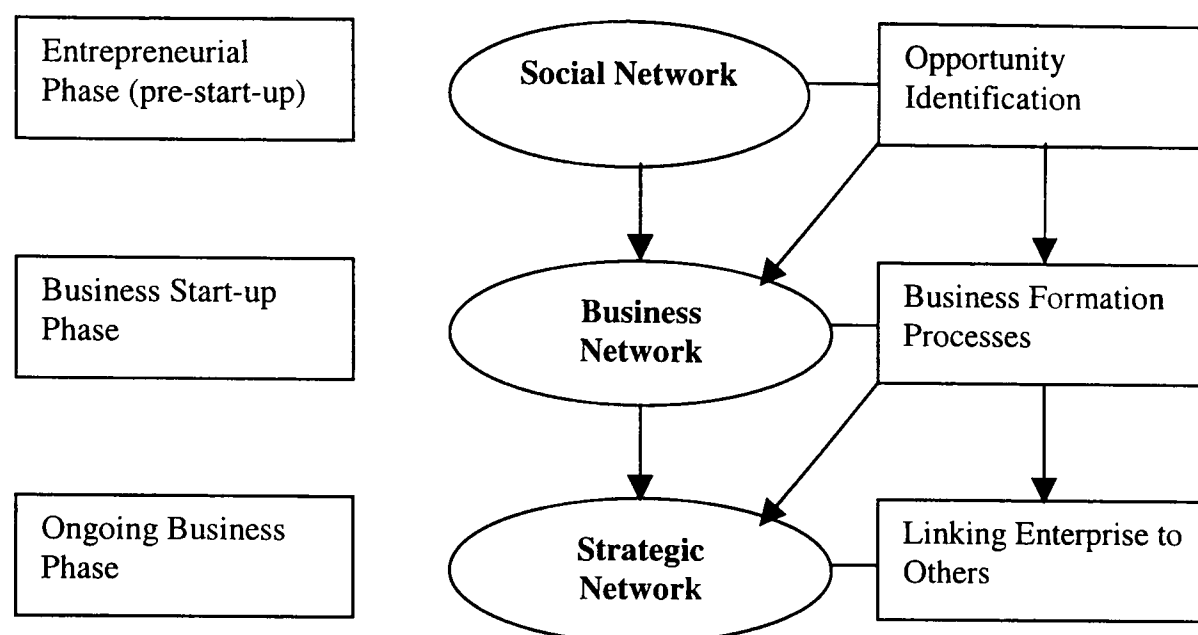
Johannisson (1996) suggests that both calculated and social interest and a blending of commitments in individual network ties creates ongoing exchange within the network and a level of 'social embeddedness' (Granovetter 1985) that creates the energy that drives the network processes. Johannisson suggests that the integration of social and business issues create individual ties between network participants that are unique; therefore, any addition or departure of individuals creates change in the network. Likewise, Walker (1998) suggests that ongoing entry and exit of network actors ensures that the evolution of the network does not follow a predictable path.

The outcome of repeated interactions that over time and emerge into a complex tie leads to the concept of *network evolution* (Johannisson 2000). Network interactions will evolve not only through changes to members, but also due to both market changes and internal changes to each venture, thus contributing to technological development and innovation (Hakansson 1987).

One model of entrepreneurial network evolution, by Larson and Starr (1992), suggests that network relationships evolve from simple single-dimensional personal exchanges to multi-layered inter-organisational relationships. This evolution of exchange, beginning from the personalised relationships of the entrepreneur, is seen to lead to the successful mobilisation of critical resources for the enterprise. A key assertion by Larson and Starr is the relationship between the network exchange, or 'crystallisation of relationships', and the level of successful mobilisation of resources, such as the revenues that are realised via the network.

Figure 4.2 shows another model of network evolution proposed by Butler and Hansen (1991:3) comprised of three stages: the entrepreneurial phase, the business start-up phase, and the ongoing business phase.

Figure 4.2: Model of Entrepreneurial Network Evolution
(Butler and Hansen 1991: 3)



The model stresses the importance of informal social contact as a starting point to knowledge acquisition for the entrepreneur. Initial contacts from social networks evolve into business-focused networks, and then into strategic networks, which allow firms to innovate and to thrive by their links to other organisations (also Falemo 1989; Dubini and Aldrich 1991; Aldrich and Zimmer 1986).

The first phase of the Butler and Hansen model focuses on the entrepreneur's social network that provides an 'opportunity set' from which the entrepreneur can draw intangible and tangible resources. The second phase of start-up sees the network activities of the entrepreneur become more focused on those that serve the more immediate requirements of the new enterprise, although the entrepreneur maintains the social ties within the network. The third phase of network evolution is the strategic network that emphasises the active role of the entrepreneur in choosing network exchange according to the value of its contribution to the success of the enterprise.

Hakansson and Snehota (1995: 271-77) view the network itself as a 'continuously organising process' that includes both continuous and evolutionary change. They argue that a network of business relationships is never stable and thus a business

network will possess inherently dynamic features. Specifically, they argue that it is the links, ties and bonds between network actors, developed in one relationship and connected to others, that provide the sources as well as effects of change. They further suggest that although networks may become more elaborately connected and more tightly structured over time, this is likely to slow down as incremental adaptations move the interaction towards a steady state.

Literature describes certain factors affecting interaction and exchange over time. Garnsey (1998) views evolutionary network development as being influenced by the nature of the entrepreneur's social skills and motivation to seek out pre-selected business contact, among other factors. Garnsey suggests that successful mobilisation of critical resources through network contacts further allows the entrepreneur access to new resources and to establish new network ties that contribute to further growth of the enterprise. Falemo (1989) suggests that once enterprise formation and start-up are complete, the needs of the enterprise become more complex, required different types of networks.

Johannisson (2000) suggests the importance of proximity to initiate and build personal ties is required for networks to be successful. He argues that the freedom of interaction, reflected in a lateral network structure that crosses over any formal structural predispositions brought into the network, is critical to entrepreneurial venturing. He adds that this is because the need for independence is a primary motive for business start-ups.

Granovetter (1985) argues that trade relations become less personalised and embedded in evolving social relations the greater the geographical, social and cultural distance between the traders. Research by Bramanti and Ratti (1997) have found that short distance favour information contacts and exchange among economic actors and increase the opportunity to meet and consult, which is considered crucial in the early stage enterprise.

Proximal social networks are seen as collective repertoires of prior experiences that provide learning and advice on the competencies of successful businesses to those seeking to operate a successful new venture (Vesper 1990; Johannisson 1995). Previous entrepreneurs share business knowledge that includes business operations, regulations, taxes, accounting, suppliers, customers, and marketing and distribution. However, Hausmann (1996) argues that proximity in a physical sense is less limiting on inter-organisational linkages with the advent of modern modes of communication such as e-mail, mobile communication and facsimile.

Lundvall (1992) suggests the importance of both proximity and time for networking success: proximity favours information contacts and exchange among actors and time favours long-term exchange and the creation of trust and shared understanding.

4.2.3 Network Management and Intermediation

Literature identifies an intermediary and management dimension to networks. Burt (1987) suggests the role of 'mediator' that can be taken up by those who will charge to facilitate exchange of resources between different groups within a network. This role is available because of the fact that innovators often provide inducements to obtain the desired support and contribution from others that include offers of financial incentives, resources, information, policy promises, learning experience and personal development (Kanter 1980; Pfeffer 1981).

Similarly, Casson (1997) argues that transactional economics accommodates an 'intermediary or co-ordinating role' that reduces the overall cost of managing the network for the participants. He suggests that intermediation between organisations that would not otherwise interact at a certain level and the facilitation of information flows legitimises a cost to participants.

Steier and Greenwood (2000) identify a considerable challenge in organising and managing a network that is comprised of various actors, roles, expectations and perceptions. Gelsing and Nielsen (1996) note that the main reason why external

efforts to build networks often fail is because value-adding assets or capabilities are absent among external network builders. Pihkala *et al* (1999) found that value-adding is crucial in a dynamic network, and that membership in a network is contingent on the value to other partners. Larson (1991) suggests that building a web of shared understanding, trust and pursuit of common goals is identified as a general objective of network intermediation and a general characteristics of successful networks.

4.2.4 Research and Evaluation of Networks

Various gaps in understanding entrepreneurial networks are suggested. Monge and Contractor (2000) suggest that literature on networks have focused primarily on the exchange and dependency relations within or between *existing* organisations or on structural characteristics such as network size, density and strength of ties.

Rangan (2000) argues that although evidence supports the view that social networks influence economic action, researchers need to sketch more clearly when and why, even when economic objectives dominate non-economic ones, networks really matter. Chu (1996: 358) suggests a more general observation that the use of networks to explaining entrepreneurship has been 'limited'.

Particular difficulties are identified in evaluating how networks make a difference to companies (Curran and Blackburn 1994; Johannisson 1995). Gulati *et al* (2000:199) state: "*though we have many answers to the question: 'why do alliance and networks exist?' we have fewer answers to the question: 'Do alliances and networks really matter when it comes to firm performance?'*"

One problem is the conflicting nature of evidence regarding a causal relationship between networking and enterprise performance. Some studies have identified that features such as scope of the network and time invested by the enterprise do not increase venture performance (Johannisson, 1996; Reese and Aldrich 1995). Hansen (1995), on the other hand, found that first-year growth of new ventures was strongly

related to personal-network properties, such as interconnectivity and size, while Brown and Butler (1995) found that networking with competitors rather than upstream and down-stream business partners fosters firm growth.

Attribution of network support effects to new enterprises is made difficult by multiple factors explaining enterprise growth - that include random factors and those uncontrolled by the enterprise (chance, timing, macro-economic change, sectoral conditions) as well as various systematic factors such as capital investment, entrepreneurial skills and motivations, location, etc (e.g Birley and Westhead, 1990; Westhead *et al.*, 1993; Storey 1994).

Reynolds and White (1997) suggest that few researchers actually study enterprises going through the start-up process, since most research studies successful new ventures already founded. Similarly, Autio (2000) identifies a lack of research on technology-based new enterprises, the “spin-off stream” in their formation and growth phases.

Another identified research challenge is the context of entrepreneurial learning and knowledge accumulation as a collective for the enterprise that is not easily traced as deriving exclusively from any specific network. Sanberg and Logan (1998) identify the challenge of isolating attribution effects in describing an entrepreneur’s “network” as multiple networks defined by the resources each network provides.

Barnett (1995) suggest that, with the emergence of virtual enterprises, the network itself is the primary actor, and member identity, whether enterprise or individual, dissolves. Sedaitis (1997: 142) claims that “*the founding network reproduces itself in the organisation it creates, facilitating a different type of organisational structure and strategy*”.

Literature describes methodological difficulties in taking the network itself as unit of analysis. These include the social or informal character of many networks

(Johannisson 2000) and difficulties in tracking how the network facilitates the ability of new firms to *assemble* resources and capabilities (Malecki 1997).

Grandori and Soda (1995:184) find that the understanding of the initial stages of network development is particularly lacking, despite their assertion that networks are at the core of organisation theory. Although models of entrepreneurial network evolution describe potential stages of network growth and characteristics, there is little information on how networks are enacted and formed and for what purpose.

It is argued that most empirical studies on entrepreneurial networks are retrospective in design and establish the network at one place in time, while networks are identified as dynamic entities, transforming through constant change to exchange relationships among actors (Butler and Hansen's 1991). Gibb and Davies (1991) suggest evidence is lacking as to how network evolution impacts business growth and their processes in gradually accumulating capabilities and resources. Other research identifies the need for longer research time horizons to capture network effects on actors that will not be immediately identifiable (Segal *et al* 1985; Smallbone and North 1996).

The need for methodological improvements to evaluate networks is suggested by Tichey *et al* (1979:507): *[the network] model of organising, if it is to move beyond the metaphorical stage, requires a coherent framework and accompanying methods of analysis that are capable of capturing both prescribed and emergent processes*".

4.3 SUMMARY

This chapter has identified networks as social structures distinguished by their membership of actors, exchange relationships, purpose, level of formality and organisational structure, among other features. Entrepreneurial networks are described as an important social mechanism for gaining access to local resources and capabilities that is particularly for early enterprise formation. Literature suggests that

networks evolve over time not only through changes to members, but also due to market changes and resultant effects on network actors that can facilitate ongoing technological development and innovation that in turn feeds back into the network. Evolutionary models of networks suggest that networks build up over time through activity links, actor bonds and social and business exchange.

The unit of analysis for network research can be the enterprise or the network itself, although research appears underdeveloped in accounting for the impact or value of networks on the resource acquisition processes of new enterprises. Research difficulties include the primarily social or informal character of many networks and difficulties in tracking how local supportive mechanisms allow new firms to assemble resources and capabilities. A further difficulty is tracking the interaction activities between network actors and the social processes leading to value exchange.

Literature suggests considerable challenges in organising and managing various network actors, roles, expectations and perceptions, although the management dimension of networks or network intermediation is described in the literature as an important role. Few studies are identified in the literature that have examined the management of regional networks and the intermediation of resources and capabilities that facilitate network membership, social engagement and business exchange.

Implications from this literature to the research intent of the thesis identify first of all the relevance of networks as a social structure for organising the collective capabilities and resources for innovation exploitation and for facilitating the creation and development of new enterprises. Second, the characteristics of a regional support network – its structure, function, evolution and ultimately its benefits – is expected to be strongly associated with the interactions and activities of technical and entrepreneurial actors and supportive institutions sharing network affiliation and motivated by a common goal of successful commercial gain.

CHAPTER FIVE

THE TECHNOLOGY-BASED ENTERPRISE, TECHNOLOGY REGIONS AND NETWORKS

“Networking leads to two phenomenon. One is the necessity for physical proximity because no technology, not even the internet, has yet to supplant the importance of face-to-face contact on a regular and routine basis. The other is the speed at which business is conducted. Silicon Valley is a ferment not just of start-up companies, which attract the most attention, but of mergers and acquisitions, tactical and strategic alliances, continuously evolving business plans, venture capital financing, public offerings and product roll-out – all operating at a pace many times faster than conventional industry.”

David Rosenberg, “Cloning Silicon Valley (2002: 3)

5.1 INTRODUCTION

This chapter narrows the focus from previous chapters to discuss technology-based enterprises, the regional context from which they emerge and the relevance of networks to their creation, formation and growth. The chapter first discusses characteristics of technology enterprises that distinguish them from more ‘traditional’ firms and discusses the market dynamics that challenge commercialisation activities. This includes discussion on the ‘spin-out’ or start-up’ enterprise commonly associated with academic entrepreneurship and factors contributing to university-industry collaboration in exploiting technologies.

The chapter then explores regional factors affecting technology entrepreneurship that incorporates a broad base of theories and perspectives, e.g. national and regional systems of innovation, clusters, knowledge transfer and network theory. Factors that characterise ‘successful’ technology regions such as Silicon Valley describe the elements and conditions that facilitate knowledge transfer through collaboration and networking.

5.2 TECHNOLOGY-BASED MARKETS AND ENTERPRISES

This section describes characteristics of technology-based markets and enterprises that distinguish them from conventional markets. Already suggested in previous chapters are the dynamics of technology-based market sectors that are characterised by rapid changes that affect entrepreneurial processes such as opportunity identification, investment, market entry and profitability (Foreman-Peck 1985; Porter 1998; Birkinshaw 2000).

Dynamic market factors relate to Schumpeter's notion that innovation and entrepreneurship revolutionise the economic structure from within through the processes of creative destruction where old methods are replaced by new innovations as entrepreneurs seek new profit opportunities. Kirzner (1973) points out that high levels of change and uncertainty in the market provides disequilibrium conditions that will produce differences in entrepreneurial activities and profits because of differences in knowledge among entrepreneurs, their perception of the market opportunity and ultimately how the resources for exploitation are configured.

Technological innovations in particular can dramatically affect change and alter the market and competitive landscape of industry sectors in the economy (Schumpeter 1934, 1943; Usher 1955; Coombs *et al* 1987; Mokyr 1990; Giget 1997). Using a historical perspective of technical invention, Schmookler claims that the interplay of advancing knowledge opens up new inventive opportunities for exploitation and consequent unfolding of new economic needs and opportunities arising out of a changing social order.

Schmookler's argument that the introduction and use of a new technology provides opportunities as well as challenges relates to Schumpeter's assertion that new innovations create changes within the economy beyond the good's immediate commercial application (Schumpeter 1928, 1934, 1949; Usher 1955; Schmookler 1962). Schumpeter refers to this recurring change in terms of 'gales of creative

destruction' that are brought about through new resource combinations that characterise innovation.

Schumpeter's assertion that innovation and technical change are key to economic development and growth can be linked to enterprise growth theories in describing technological opportunities and threats. For existing enterprises, increased R&D spending and alliances, joint ventures and mergers are strategies for coping with change and avoiding the decline stages of growth. But larger enterprises may respond slowly, subject to strategic and organisational inertia, in addition to protecting existing product lines and past R&D investments. These conditions provide market opportunities for new entrepreneurial ventures (Dosi *et al* 1994).

Under such conditions of market uncertainty, innovation is seen as an interactive learning process (Asheim and Cooke 1999). This process is associated with a complex and continually changing array of both technological opportunities and threats and market opportunities and threats, linked to patterns of new product development, commercialisation and adoption/diffusion.

Usher (1955) introduces the notion of '*technology diffusion*' and states that the consequences of diffusion of a new technology throughout the economy presents a set of economic problems that include growth from technical change and limitations due to scarcity of resources. Deriving from Usher's notion of '*technology diffusion*', changes in technology and diffusion of technology is seen to require existing industries and enterprises in the economy to seek out new appropriate technologies, which, in turn, increase technological diffusion (Bettis and Hitt 1995).

The *high technology market* is defined by Westhead (1994) as a general category actually comprising a wide range of sectors such as electronics, software and biotechnology and asserts that each may be completely different in terms of business needs and requirements. Differences between high technology sectors exist according to differences in markets, according to Autio (2000) who suggests that assuming a single high technology sector runs the risk of relegating the market into a

passive role. Blakely and Nishikawa (1992) have found that each technology sector will have its own support systems, noting that communications or networks are critical in realisation of economic gains.

In describing the *high technology enterprise*, Segal *et al* (1985) found a number of dimensions common to all enterprises across a variety of technology sectors in their study of the 'Cambridge Phenomenon'. These include how an enterprise copes with risk; how their financing needs are met, and how this changes over time; how their product mix changes; and how their marketing and management systems develop. They suggest that the combination of these characteristics present a whole set of basic management problems for high technology compared with conventional small enterprise.

Segal *et al* observed that high technology enterprises require substantial start-up investment for the required set up costs. They found that larger, established enterprises often have enough resources to invest in marketing, research and development (R&D) of new products, thus reducing the competitiveness of new entrants. Other advantages over new entrants include market knowledge, networking with customers and suppliers and practical business management skills. Advantages such as branding, advertising, packaging and signage were found to be especially important differentiating requirements for many enterprises competing in a global marketplace. They also found that creating customer awareness and building customer loyalty could be difficult for a new entrant because of lack of resources.

Technology-based enterprises are identified with focused strategies for successfully competing in dynamic markets (Maidique and Patch 1982). They include: 1) niche: firm specialises on servicing narrowly defined customer or application niches; 2) cost-minimisation: firm attempts to gain advantage through development of cost-efficiencies; 3) first-mover: firm is the first to introduce a new product to market and exploit a temporary monopoly as first entrant; and 4) fast-follower: firm relies on rapid imitation of new innovations introduced by competitor(s).

Literature emphasizes the importance of difference factors that contribute to high levels of failure among high technology-based enterprises. Malecki (1997) found that a key factor is shortage of resources, including capital, information and skills while Oakey (1994) suggests that mobilization of resources for new product development is the central focus for constraints on the firm.

Storey (1994) finds that the survival of any business is in part a function of the management's ability to secure and gain access to finance and working capital. Similarly, Haswell and Holmes (1989) found that managerial inadequacy, incompetence, inefficiency and inexperience were found to be consistent themes in failures. Poor management was connected with poor financial conditions, inadequate accounting records, limited access to necessary information, and lack of good managerial advice. Gadenne (1998) finds that specific management/business practices are related to return on investment and are unique to industry groups; value for money in retail, employee relations in service industry, and competitive advantage in manufacturing.

Part of the problem for growing firms, Bhidé (2000) suggests, is to distinguish between the entrepreneurial function and the managerial function. Whereas the entrepreneur conceives the initiation of the enterprise, this is not the same as running a successful growing business that requires different and specific management skills. He states that the entrepreneur then must either incorporate the required skills within the enterprise either personally or via recruitment.

Powell (1998) states that collaboration with others may speed up the innovation process and allow the enterprise to gain access to the emerging industry. Similarly, Lipparini and Lorenzoni (1993) note the importance of product innovation and accumulation of knowledge as a primary reason for ongoing networking. Other literature has found that innovative enterprises more often have co-operative relationships than enterprises without innovation (Johannisson 1996; Fritsch and Lukas 1999).

The need for a balanced venture team in the start-up process has long been recognised (e.g. Kroeger 1974; Cooper 1979; Kanter 1982; Drucker 1985; Cooper and Daily 1997). Glancey (1998) suggests that growth beyond the entrepreneur's capabilities can negatively affect profitability and growth, and supports the need for "collective entrepreneurship" that he describes as those specific skills and competencies in addition to the entrepreneur that are required for enterprises in high technology industries.

Segal *et al* (1985) suggest that the critical requirement in the early stages of development is assembly of the right team of key individuals. The emphasis that financial supporters places on formation of such a team is epitomised by venture capitalists, who often appoint the management team as a prerequisite to financing. The support through the critical start-up and formative phases may require new skills and competencies that are unknown to the entrepreneur at the time.

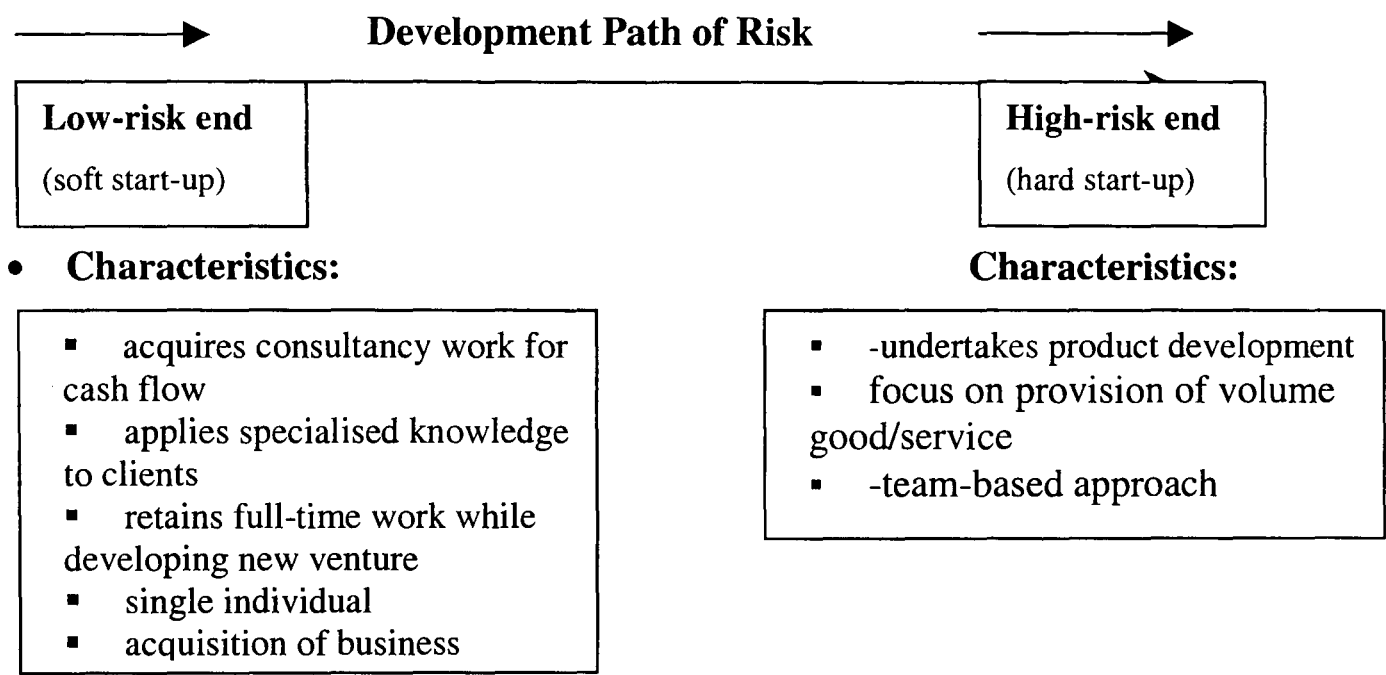
At the same time, Segal *et al* found that building a new venture team is difficult and potentially expensive. The entrepreneur may not be qualified to manage or put together such a team, so an experienced manager may play an important role. Outside consultants have been a popular trend in specific roles, such as technicians and marketing, and in areas like strategic management.

Bullock (1984) suggests a model, shown in Figure 5.1, for the start-up and growth of high-technology spin-off companies after studying such firms at Massachusetts Institute of Technology and Stanford. The key feature of his model is that there is a spectrum of risk, financial and technological, that faces a young high technology company.

Bullock observed that there was a growing trend in US companies to skip the early stages and become fully 'hard' more quickly. This was due to the 'recycling' of technological entrepreneurs as they spin out to start again from the large companies that had acquired their first venture. A key feature of the soft company is the importance of early revenues to minimise cash flow problems and to build up cash to

assist later stage development. Another factor was the ability of the financial and business services community to understand and support young advanced technology enterprises.

Figure 5.1: Bullock’s Risk Spectrum for High Technology Start-ups



Segal *et al* (1985) found that shortage of capital was not a limiting factor in Cambridge on the start-up and development of new ventures they studied. They point out that most firms comprising the Cambridge phenomenon were made up of companies at the softer end of the Bullock risk spectrum. High proportions of these were concentrated on research-design-development activity.

A large body of evidence suggests that technology-based enterprises are particularly challenged by the ability to access new and specialised *knowledge resources*, rather than traditional factors such as access to raw materials and transportation costs (e.g. Jain 1984; Rothwell 1990; Julien 1995; Almeida and Kogut 1997; Cooper and Folta 2000). These include scientific and technical staff, capabilities for research and development, and increasing size and complexity of the enterprise requires an increasing need for a systematic scanning process. A study by Galbraith and DeNoble (1988) studied 226 high-technology firms and found that three of the five most emphasised factors relate to availability, productivity and retention of skilled labor.

Collinson (2000) suggests that small, start-up enterprises are arguably constrained far more by knowledge limitations than by financial limitations and that *networks* may act as the source of several kinds of critical knowledge or expertise, particularly:

- ◆ strategic: helping them match technological and market opportunities
- ◆ managerial: supporting the human-resourcing, organisation and financing of the new enterprise
- ◆ technical: assisting with design and development of core products and relevant technical alliances

Collinson (2000) suggests that in times of rapid change, networks are central to the development of successful ventures. Drawing on the notion of 'social capital', Collinson argues that the socially constructed and mediated nature of knowledge and expertise is a central question in understanding how entrepreneurs access particular kinds of specialist knowledge to support a new enterprise. Collinson suggests that this requires an understanding of more complex factors, such as the incentives for knowledge-sharing, as well as the relative ease or difficulty of knowledge transfer of benefit to the venture in its particular setting.

5.3 ACADEMIC ENTREPRENEURSHIP, 'SPIN-OUTS' AND UNIVERSITY-INDUSTRY COLLABORATION

In recent years, there has been a growing trend towards integrated efforts involving government, universities and industry in commercialising scientific research (Giget 1997; Howells *et al* 1998). Giget suggests this trend is driven by factors that include global interaction of a high level of research in technological innovations, high uncertainty and the need for greater economic returns from research.

Literature describes the '*triple helix model*' that involves university-industry-government interaction toward research activities and exploitation (Etzkovitz and Leydesdorff 1997, 1999). A key premise of the 'triple helix model' is the interaction of support activities internally from within the university and externally from the

regional support system. The interactions between universities, industry and government are seen as providing a mutual interdependence and a foundation for a 'regional advantage' often seen in the commonly cited successful high technology regions of Silicon Valley, Cambridge, Mass. and Cambridge, UK.

It is acknowledged that a university is one of the elements in the support structure to create and develop new enterprises (Walshok 1994; Maleki 1997; Botham and Eadie 1997). It is also acknowledged that various factors - market and industry forces, regional support, management and founder characteristics and enterprise product and market strategies – are critical factors relating to the new spin-out (Downes and Eadie 1996; Howells *et al* 1998).

Evidence suggests that the assumption that universities function as “knowledge centres” around which innovative enterprises will cluster is unrealistic (Massey *et al* 1992; Nijkamp and Mouwen, 1987). Malecki (1997) cautions that the presence of a local university is not enough to offset shortcomings in entrepreneurial climate. Walshok⁵ (1994) argues that university-industry partnerships cannot achieve their intended consequences without parallel and reinforcing knowledge linkages which assure a policy environment supportive of economic growth, a regional infrastructure ready to support new and renewing industries and an appropriately competent, informed professional and technical labour force.

Much has been written about *spin-out* enterprises that have been successful in the commercial exploitation of innovations from US universities, such as Stanford and MIT (Monck *et al* 1988; Westhead and Storey 1994; Saxenian 1994; Walshok 1994; Downes and Eadie 1996; Malecki 1997; Howells *et al* 1998). Bank Boston (1997) for example, suggests that graduates of the Massachusetts Institute of Technology (MIT) have founded some 4,000 currently active enterprises, with annual revenues of almost US\$232 billion and 150 new MIT-related companies founded each year.

⁵ Mary Walshok, as co-founder of Connect San Diego, argues that success of the university-industry program in operation since 1985 is the result of a combination of factors: infrastructure support includes an interrelated production network of large and small enterprises, a thick layering of public and private industrial support institutions and skilled labour and risk capital. Regional services include tax incentives, high-grade labour-market intelligence and associated vocational training, rapid diffusion of technology transfer, a high degree of inter-firm networking; receptive firms well disposed towards innovation, demand for new knowledge-intensive products, entrepreneurial strategies and competition and a vibrant socio-cultural base.

Another cited example is Chalmers University in Gothenburg, Sweden. Over the last 30 years, over 240 spin out companies have emerged *directly* from the university, creating over 2,700 jobs with over 75% of companies still in existence (Downes and Eadie 1996). Since 1970, Chalmers has adopted policies intended to minimise barriers to the establishment of spin-out enterprises, such as granting individual academics the rights to intellectual property generated by their research and providing part-time academic contracts to facilitate academic-commercial activities. Downes and Eadie suggest that this output of commercial exploitation is remarkable given Sweden's socio-economic background characterised by high tax rates, limited financing for start-up companies, aversion to personal risk and negative attitudes toward conspicuous personal wealth.

By comparison, a survey by the Financial Times (FT, April 9, 2001) on UK university spin-outs and start-up ventures found 258 spin-out companies and a further 138 start-up companies had emerged from 59 UK universities in the past 3 years, with a combined value of £143 million. One difficulty in understanding how UK universities exploit technology-based innovations that exploitation processes and output are not standardised and monitored. Howells *et al* (1998) found limited data on the number of inventions disclosed, patents filed, licences granted and royalty income in addition to the research income generated.

In comparison to the UK, universities in the US and Canada have their exploitation activity assessed and compared as members of the Association of University Technology Managers (AUTM) through a detailed survey over several years (ERI 2000). Although a growing trend is UK institutional involvement in AUTM, the lack of standard technology transfer policies and monitoring increases the difficulty of identifying and evaluating and comparing commercialisation processes.

An identified difficulty in understanding the role of universities in enterprise creation is confusion over what defines or constitutes a university company. The Financial Time for their 2001 survey defined a 'spin-out' as a company set up to exploit research from the university that had raised external finance from investors and

defined a 'start-up' as an independent company in which the university had taken a share of equity.

According to Howells *et al* (1998) enterprises created and remaining under the direct and ongoing control of the university are termed 'umbrella' organisations or 'spin-offs', while enterprises with no formal links with their former universities are referred to as 'spin-outs'.

A further definition of a spin-off company is a new company that is formed (1) by former employee(s) of a parent organisation, (2) around a core technology that originated in, and then was transferred to, the new company (Carayannis *et al* 1998). In this definition, a university-related start-up company (essentially similar to a spin-off) obtains a new technology by licensing it from a university's technology transfer office.

Re-examination of MIT spin-off results from these definitions suggest that much of the publicised success of their university 'spin-outs' is referring to 'start-ups', those companies that have been created from previous graduates of the university, not companies that have been involved with university technology transfer services. Bank of Boston estimates of 'spinouts' includes all *MIT-related* companies, including those companies set up by any alumni of MIT (BankBoston 1997).

Literature suggests a number of challenges in studying academic spin-outs. AUTM found that for most US universities there is an emphasis on disclosing and understanding the outputs of commercialisation activities and enterprise creation without a corresponding understanding of costs and inputs (AUTM 1999).

In the UK, it is suggested that research on university commercialisation activities has focused mainly on effects of science parks and support programs (Monck *et al* 1988; Westhead and Storey 1994). High-profile English science parks at Oxford and Cambridge universities are held up as examples of successful models to create and develop high technology enterprises (Howells *et al* 1998). Oxford's science park

mission, for example, is to attract international calibre laboratories and to provide facilities for smaller, rapidly expanding enterprises that include spin-outs or start-ups from the university.

A further problem for research on university enterprise, according to Autio (2000) is the lack of a theoretical basis in understanding formation and success factors. He states that this is the result of absent or poor theoretical frameworks, little or no attention to industry influences and sampling in research design not well established or guided by theory.

Studies suggest that multiple factors influence and motivate academics to commercially exploit research opportunities and create new companies (Segal *et al* 1985; Botham and Eadie 1997; Howells *et al* 1998; Cripps *et al* 1999). However, few studies have assessed the *role* of scientists - academics in starting up new companies and following them through the processes of company formation and growth.

Howells *et al* (1998) identifies high growth in recent years across the United Kingdom in the scale, number and variety of linkages between higher education (HE) and industry. These linkages are manifested in research collaboration, provision of consultancy services, market transactions in the commercialisation of research, and industry's growing involvement as an interactive user of all types of teaching and training.

5.4 REGIONAL PERSPECTIVES ON INNOVATION AND ENTREPRENEURSHIP

The concept of *regional entrepreneurship* derives from network studies and economic geography literature that examines economic and production structures, linkages between these structures and the relationships between productive enterprises (e.g. Cooke and Morgan 1993; Yeung 1994; Storper 1997). Much of the

economic geography literature has been concerned with agglomeration economies and the regional implications of networks (Malecki 1997; Oakey *et al.* 1999; Cooke *et al.* 1998, Cooke 1996).

Complementing economic geography literatures are innovation studies that examine the distinctiveness of regional institutional infrastructures and mechanisms for interaction and co-ordination mainly through contrasting '*national systems of innovation*' (Edquist 1997, Freeman 1995, Nelson 1993, Lundvall 1992). The notion that participants in effective and efficient innovation networks reap 'additional returns' from the associated competitive advantages is paralleled in the regional economic development policy literature (Huggins 2000, Ritsila 1999).

Regional *industrial districts*, drawing on previous work by Marshall (1920, 1986) are described as networks of local independent firms that contribute to economic development with *knowledge* and *organisation* prerequisite success factors. More recently, Piore and Sabel (1984) suggest that geographically concentrated business networks have emerged as a consequence of restructuring in industrialised economies and pose a challenge to large-scale mass production.

Innovation system and industrial district literature focus attention on regional institutions and organisations that facilitate knowledge development and learning. Lundvall (1994) stresses that "*knowledge is the most strategic resource and learning the most important process of economic development, that successful innovative regions can be viewed as externalised learning institutions*".

Lawson and Lorenz (1999) describe the notion of regional collective learning as involving both conscious and unconscious mechanisms. A conscious mechanism would be the deliberate collaboration between technology transfer personnel and scientists in creating a spin-out company, while an unconscious mechanism would be the 'spontaneous movement' of knowledge workers and experienced managers among existing and new firms. They also identify *collaboration* and *competition* and the balance between the two as key success factors to regional economic growth.

Regional entrepreneurship also draws from the resource-based view of enterprise (e.g. Penrose 1959; Teece 1996) and clusters (Saxenian, 1994) to suggest that innovation, growth and competitiveness for enterprises are optimised by access to resource and capability 'assets'. These assets are often exclusive to the enterprise and the regions and clusters in which they operate. Within this literature, evidence suggests that regional factors strongly influence the creation of successful start-ups (Cook and Morgan 1993; Porter 1990; Malecki 1997).

Other approaches have been suggested to examine these concepts describing regional entrepreneurship. For example, Johannisson (1993) found support for four alternative models that explain regional entrepreneurship:

1. Market model: the demand for products/services in a region
2. Resource model: availability of inputs needed to start a new firm
3. Milieu model: a positive orientation towards entrepreneurial activity as an integral feature of the region's economic specialisation
4. Career model: positive value placed on entrepreneurship as a career option

The essential argument behind these descriptions of regional entrepreneurship suggests that the spread of innovations and commercial success as a function of the support that innovators can draw from the larger community as well as industry conditions (Pfeffer and Salancik 1977; Ruttan and Hayami 1984). Support factors include access to investors and those funding technology-based enterprises, small to medium-sized enterprises that may collaborate with universities in new company formation, service providers of marketing, management and technology verification, or due diligence services and others that exist in the region to promote and support the development of start-up enterprises.

The Silicon Valley region provides one of the first 'ideal models' with high levels of technology-based enterprises underpinning a dynamic, high-growth regional economy that other regions seek to emulate. Research by Saxenian (1991, 1994) on Silicon Valley identifies certain characteristics of this region seen to enhance entrepreneurship. She emphasises the importance of deep, long-lasting and equal

relationships that has given rise to 'complementary innovation' that allows enterprises to focus on specialisation to be more competitive while providing suppliers the ability to develop into sophisticated and less labor-intensive companies.

Expertise in Silicon Valley is spread across hundreds of specialist enterprises that continue to develop independent capabilities while simultaneously learning from one another. Complementary innovation through collaboration also spreads the costs and risks of developing new products while enhancing their ability to quickly adapt to changing markets and competition. Collaboration occurs through a proliferation of inter-firm networks, resulting in an ongoing dynamism of the region even during economic downturns according to Saxenian.

Attempts to emulate the success of Silicon Valley have also drawn from the idea of the '*entrepreneurial infrastructure*' (Vaughn, 1983; Porter, 1990) that describes the facilities and services present within a given geographical region which encourage the birth and development of new enterprises. It is based on the premise that new enterprise creation will be affected by factors that include access to capital, specialised inputs, proximity to customers, specialised labor and psycho-social support (Porter 1998; Cooper and Folta 2000). For example, Bygraves (1988) found that, for venture capitalists, networks provide information on possible good investment opportunities and may be particularly appropriate in an environment where there is a need to generate a constant stream of new "deals".

The ability to access knowledge and resources may be easier for enterprises located in '*clusters*' based in one geographical area (Prevezer, 1997; Almeida and Kogut 1997; Cooper and Folta 2000). Clusters are seen to occur for many types of industries and associated enterprises (Porter, 1990) but location in a cluster may be particularly relevant for start-ups and small enterprises (Almeida and Kogut, 1997). The concept of clusters as an intervention strategy for stimulating technology entrepreneurship will be further discussed in Chapter Six.

The growth of technology regions such as Cambridge UK identifies the need to maintain support infrastructures in the form of physical facilities. Segal *et al*'s follow up report, 'The Cambridge Phenomenon Revisited' (2000) suggests that Cambridge's infrastructure is not coping with its rate of growth⁶ and requires sizeable investments in roads and public transport. At the same time, regional policy-makers are challenged with balancing economic growth for regional and national prosperity with regional quality of life for regional residents.

5.4.1 Knowledge and Capability Transfer and Networks

A common theme identified in research on US-based technology start-ups is the benefits from spill-over effects in knowledge, capabilities and social contacts resulting from a high concentrations of dynamic enterprises and support businesses that combine to contribute to regional economic prosperity (Saxenian 1994; Walshok 1994; Downes and Eadie 1996; Malecki 1997). Contributions of the end user in technological development acknowledge the variation by industrial sector of producer and user input in innovation development.

The term '*knowledge spillover*' describes interactions with others that may lead to a positive contribution to new technical knowledge (Lundvall 1988; O'Farrell, Hitchens and Moffat 1992). It is forwarded that through these interactions, enterprises are able to enhance their technological capabilities by learning from customers and from suppliers, by interacting with other firms, by searching for new technologies and by taking advantage of knowledge spillovers from other industries.

The value of different kinds of knowledge in different contexts (Williams *et al* 1998) and the long-standing link made between knowledge and power are important factors directing flows of knowledge in networks (Hislop *et al* 2000). Indeed, Steier and Greenwood (1995) suggest that 'financial capital' can also be directed in networks through venture capitalists, who can act as 'brokers' linking entrepreneurial ventures

⁶ In 1998 there were 1,350 high-tech firms employing 32,500 people, three times the number of companies than in 1985.

with such players as marketing consultants and other financial sponsors. Similarly, Coombs and Hull (1997) examine knowledge accumulation mechanisms, interface mechanisms and deployment mechanisms in the context of innovation networks. Howells (2000) also connects innovation systems with knowledge systems.

Various levels of knowledge transfer are identified in the literature. Badaracco (1991) identifies *migratory knowledge* as knowledge that is easily transferable within a region to various locations. Knowledge that is delivered consistently by the same individual or group can provide a *representative linkage* in the case of agency services and provision of standardised topics to similar audiences. *Institutional linkages* describe knowledge and information exchanged without the involvement of the same representative personalities, with institutional interests prioritised (Eisenberg *et al* 1985). Conversely, *personal linkages* describe knowledge transfer between people representing their own interests.

Knowledge spillovers are seen to occur through formal and informal channels of *networking* (Cooper and Folta 2000). Networks are seen as most appropriate for new and hybrid models of enterprise forming in response to rapidly changing technology, high R&D costs, niche markets and electronic commerce among other factors (Shulman 1997). Formal mechanisms include technology partnerships, licensing, strategic alliances and supply contracts. Informal channels include social meetings, trade meetings and mobility of technical personnel.

Pihkala *et al* (1999) argue that the conditions in new and emerging industries favour networking even when viewing the enterprise within traditional economical models as a rational entity where individuals are engaged within relative management structures. They define *networking capability* as an action-based capacity of an individual or firm to extra-organisational activities needed to transform resources into profitable use, and contend that highly specialised and transferable resources characteristic of high technology firms cannot be put into full use without the capability of networking.

5.5 SUMMARY

Literature suggests that technology-based markets can be distinguished from 'traditional' markets by higher levels of risk and uncertainty associated with higher development costs, intense global competition and short product lifecycles. Technology enterprises require rapid access to specialised knowledge and information resources in particular that have placed greater emphasis on locality for supporting technology-based entrepreneurship.

Lessons from successful regions such as Silicon Valley emphasise the specialised facilities and services present within a given geographical region which encourage and stimulate the rapid creation, development and recycling of new enterprises, entrepreneurs and technologists. Although universities are identified as one element of a successful technology region, literature suggests that a strong entrepreneurial climate, regional support infrastructure, skilled workforce, strong university-industry linkages, regional demand for products and services and supportive policy environment are required elements.

Regional study literature identifies the relevance of networks in these dynamic market conditions that provide access to investors, technical knowledge, experienced commercial managers and market orientation. Knowledge transfer and spill-over effects are also facilitated through formal and informal channels of networking, and *networking capability* is identified as a critical element in acquiring these specialised resources and capabilities for technology-based enterprises.

Implications from this literature to the research intent of the thesis suggest the need to identify commercialisation difficulties facing technology-based enterprises in a particular regional context that expose deficiencies in the regional support infrastructure and justify the use of intervention mechanisms. Examining the role of local universities and research centres as commercialisation agents and elements of the regional support infrastructure is particularly relevant when a high level of enterprises are based on university-generated innovations.

CHAPTER SIX

MARKET INTERVENTION MECHANISMS FOR TECHNOLOGY ENTREPRENEURSHIP AND THE SCOTTISH CONTEXT

“The growth and survival prospects of new firms will depend on their ability to learn about their environment, and to link changes in their strategy choices to the changing configuration of that environment. The more turbulent is the market environment, the more likely it is that firms will fail to cope”.

(Geroski cited in Audretsch (1995): 442).

6.1 INTRODUCTION

The chapter explores perspectives on *market intervention* and various mechanisms that include clusters, incubators and science parks that attempt to counter perceived commercialisation difficulties in technology-based entrepreneurship. The chapter then explores regional initiatives and support networks – the intervention mechanism at the centre of this thesis.

Evaluation literature is examined that describes the methodological issues in establishing the effectiveness of these intervention mechanisms and the difficulties in measuring cause and effect, value for money and other common evaluation criteria that may not be appropriate measures for network evaluation.

6.2 MARKET INTERVENTION

Market intervention, according to Peterson (1988) can be described as a continuum that will reflect a particular public policy approach to small business development. At one end of the continuum is the *laissez-faire approach*, which view government activity as an impediment to spontaneous private, entrepreneurial activity by ventures. Peterson’s middle of the continuum is the *limited environmental policy* approach, which presents the government’s role as active stewardship of the economy, in creating the right climate for firms through policy instruments.

The other extreme of Peterson's continuum is the *strategic interventionist* approach that envisions government policy activism through direct aid to small businesses in the form of financial aid packages, counselling programs, procurement policies and business advocacy programs.

Justification for intervention is commonly associated with increasing the number of successful start-ups to counter high failure rates. Research suggests that although there is strong support for the argument of a high rate of companies ceasing to exist over time, it is unclear whether they are failing or have been acquired, merged, etc. For example, Bruno and Cooper (1982) studied 250 high technology firms founded in Silicon Valley during the 1960s and found that by 1980 only 31% were still surviving and independent. Other larger firms had acquired 32% of firms and the remaining 37% had ceased to exist.

One argument used to justify *regional* support initiatives is that the individual firm is too weak an instrument around which to build change (Lalkaka and Abetti 1998). Innovation development and exploitation, it is argued, is closely related to the firm's external context and the ability to access to knowledge, exchange of experience and shared resources. The external context of the enterprise is seen to define the enterprise's ability to overcome internal limitations by developing collective solutions to common problems. This public sphere of knowledge in which collective learning occurs is expected to be facilitated by public intervention activities.

Intervention provides a key focus of debate in public policy and economic development theory in terms of the degree to which the market should be left alone as the primary selection mechanism for the emergence of new enterprises. Intervention efforts, it is argued, waste resources in support of companies that may otherwise not survive market forces. Bruch and Hiemenz (1984) warn that government action and public institutions cannot serve as a panacea for all deficiencies in the functioning of private enterprise or markets, as difficulties that entrepreneurs face may reflect the market selection processes taking place and not

necessarily bias in the system. Another criticism is that companies can become overly reliant on outside assistance.

Trembley (1998) argues that, in advanced market economies, business enterprises are bathed in a plentiful supply of all the support services they need. Trembley notes that the sheer variety of organisations providing business support can appear to be a problem for any company seeking assistance.

Blakely (1994) notes that a government's primary role in promoting advanced technology development should be supportive and not directive. He found from studies of several nations that direct government involvement results at best in mediocrity and more often in disappointment. He suggests that further study is required to identify the types and effectiveness of intervention mechanisms and their role in developing the 'requisite connectivity' to stimulate new business growth.

6.2.1 Intervention for Technology Sectors

The frequent target for intervention initiatives are technology sectors, viewed by policy-makers as having greater growth potential than conventional sectors that can lead to significant regional economic prosperity (Lalkaka and Abetti 1998; Deakins *et al* 1998; Gregory and Martin 1998). High technology sectors have also been viewed as corrective for unemployment caused by the decline in traditional industries (Oakey and Rothwell 1986).

Intervention to support new technology-based firms (NTBFs) is often justified by high failure rates resulting from a myriad of commercialisation challenges that distinguish these firms from conventional new firms. For example, Blakely (1994) states that high technology firms have a complex and interrelated set of special requirements based on their stage of development, and including their size, technology base and global market position.

As described earlier, Segal *et al* (1985) found that high technology enterprises are characterised by high R&D intensity, short product life cycles, protection of intellectual property, rapid growth prospects, and early need for selling to global markets. The combination of these characteristics, they suggest, can present a whole set of basic management problems for high technology compared with conventional small firms.

Intervention efforts are expected to increase the ability of new enterprises to survive and grow that contribute to economic growth. Malecki (1997) suggests that a high rate of new technology firm formation generally signal a thriving economy. Research on US start-ups in the 1970s found that patterns of firm births were the most significant determinant of regional prosperity (Jusenius and Ledebur 1977).

Aldrich (1976, 1990) emphasises the importance of spill-over effect that can result from a growing number of successful start-ups in that, as new businesses are formed, others follow. His research found a positive economic impact of this formation, through job creation and wealth creation, particularly as more businesses move into the niche.

On the other hand, Malecki (1997) argues that new firm formation is not the most appropriate policy goal - that the ability for businesses to grow and prosper may be more important. Research by Storey (1994) suggests that employment creation depends upon being able to realise the growth potential of all new firms. Storey identified multiple factors affecting firm growth, but cautions that none appear to offer a predictive technique for consistently determining the potential of a smaller firm to achieve a growth objective. Based on research from Scotland on birth rate levels (Scottish Enterprise 1993) and on employment trends in other European countries, Storey found evidence that significant employment creation takes place in relatively few but growing firms.

Segal *et al* (1985), in their study of the Cambridge Phenomenon, caution that it should not be assumed that all new high technology firms have the potential to

become large. They note that in any economy the vast majority of businesses are small, and provide the example of Silicon Valley based on 1985 data, where some 70% of the 3,000 plus electronics/computer hardware firms employed fewer than 10 people and only some 50 firms employed more than 1,000 people.

Segal *et al* (1985) further suggest that it takes a long time to build large successful technology businesses anywhere using the example of Cambridge, where high technology firms are known for their research, design and development and production of specialised products, not in high volume production. They point out that Oxford Instruments, one of Britain's best known technology businesses which employs some 2,500 people, is just over 30 years old.

More recent attention has focused on creating the support conditions for new enterprises rather than on individual enterprises (e.g. Walshok 1994; Downes and Eadie 1996; Harrison and Leitch 1996; Malecki 1997). Research on successful high technology regions, such as Silicon Valley, Cambridge, UK and Cambridge, Massachusetts points out the critical importance of a supportive infrastructure for new and growing firms (Saxenian, 1990, 1994; Segal *et al* 2000). These elements include tax incentives, the provision of business parks and programmes that facilitate supportive agents that understand the needs and requirements of emerging and existing firms. Government intervention, it is argued, is required that stimulates creation of supportive agents and thus a critical mass of competitive firms can be established that make an impact on the regional economy.

Intervention is also identified as a strategy to stimulate and promote entrepreneurship as studies suggest that certain cultures are more effective in promoting entrepreneurship than others (McClelland 1961; Lipset, 1990). McClelland argues that the 'urge to achieve' is the single most important psychological factor for entrepreneurial success and that this trait can be acquired through training and education.

6.2.2 Types of Intervention

Market intervention can be observed at different levels through the provision of clusters, incubators, science parks and regional programs that are expected to contribute favourably to regional entrepreneurship. The importance of deliberately-constructed mechanisms - driven primarily by public-sector agencies - lies in their potential for 1) accelerating the 'learning process' for emerging ventures, and thereby accelerating the emergence of fast-growing enterprises in new business areas, and 2) promoting 'innovative milieu' and regional benefits for a high-density of fast-growing enterprises.

More direct support is identified in *business incubators*, defined by Shahidi (1998) as public-private- and university-sponsored business assistance organisations whose purpose is to support the development and growth of new enterprises through the provision of a variety of services. Incubators normally provide an array of logistical services that include office space, secretarial support and some networking opportunities, among others.

The term '*cluster*' is defined as groups of firms within one industry based in one geographical area (Prevezer, 1997; Almeida and Kogut 1997; Cooper and Folta 2000). Clusters are seen to occur for many types of industries and associated enterprises (Porter, 1990) but location in a cluster may be particularly relevant for start-ups and small enterprises (Almeida and Kogut, 1997).

Clusters may counter a key weakness of a new enterprise identified earlier; a lack of legitimacy that affects access to needed specialised inputs (Cooper and Folta 2000). Legitimacy is defined in general terms as the ability to be viewed as credible by investors, suppliers and customers (Pfeffer and Salancik 1978; Starr and MacMillan 1990). Much of legitimacy is based on a previous track record of performance. Legitimacy facilitated within a region and developed within a cluster can assist the new enterprise in attracting key management and technical people at a time when credibility and visibility are low (Cooper and Folta 2000).

Entrepreneurs in clusters may have lower search costs in finding potential investors, as geographical proximity to those seeking investors and those seeking to invest may provide substantial advantages (Cooper and Folta 2000). They found that the venture capital industry is highly concentrated geographically. Cooper (1979) found that, in Silicon Valley, 'angel investors' were former founders who had sold their businesses and become full or part-time investors in the next generation of high technology firms. Cooper found that the investors often assist the new enterprise by using their established contacts in their immediate networks.

Staber (1998) forwards three theories on why enterprises in an industry may decide to locate in the same geographical proximity. The first, transaction cost theory, forwards that locating near one's trading partners facilitates learning and more rapid response to customers and suppliers, and is important under conditions of uncertainty, such as those found in a highly competitive environment. The second, neo-institutionalism, suggests that geographical proximity can create a strong local culture that values one-to-one interactions and inter-firm resource sharing. The third, agglomeration theory, states that cost reduction can result from shared infrastructure, that include access to specialised human resources, equipment and transportation and communication facilities. Enterprises may be able to gain quicker knowledge on new market and technology opportunities.

An alternative view by Cooper and Folta (2000) claims that some entrepreneurs are relatively constrained in where they decide to locate their new enterprises. Entrepreneurs that rely upon past friendships to persuade others to gain access to specialised assets may limit their mobility (Starr and MacMillan 1990). These social contexts of entrepreneurs are seen to channel and facilitate, as well as constrain and inhibit, entrepreneurial activities (Dubini and Aldrich 1991).

According to Almeida and Kogut (1997), research reveals inconclusive evidence that new enterprises are more successful when located in clusters. They claim that only when there is sufficient technological opportunity do benefits of clustering outweigh the costs and note that a dense population of enterprises have greater rivalry for

resources and will cooperate less. Krugman (1991) forwards that clusters create a pooled market for human capital with specialised skills that benefit both workers and firms. But Krugman cautions that people with specialised skills may be lost to competitors if workers are part of a network whose members are aware of job opportunities.

Conceptually, the term 'cluster' continues to be contested, with varying definitions emerging from specific locational and disciplinary contexts. In some cases, clusters are considered from a national, or 'top-down', perspective that explores industrial structures and concentrations (Porter, 1990). In others, specific, grounded, cases are examined in detail (Pyke and Beccattini 1992). Both approaches are useful in providing alternative, but complementary, insights into clusters and clustering. On the one hand, the 'top-down' approach produces a picture of the overall configuration of a cluster. On the other, detailed studies of specific clusters offer insights into the evolution and functioning of a cluster.

For some universities and regions, science parks are presented as a key element of technology transfer policy. Howells *et al* (1998) defines '*science parks*' as all property-led initiatives for research and high technology activities that include research parks and incubators. The science park as a strategy for commercialising university research is founded on the belief that the process of developing innovative technologies and products places special requirements on facilities, services and other resources that are often not available within the original environment (Bower 1992).

Westhead and Storey (1995) suggest that science parks provide a location with a critical mass of scientifically sophisticated individuals generating new technologies and innovative ideas, many produced in universities. These technologies and ideas are channelled and diffused by new commercial ventures located in purpose-built units in close proximity to the university.

Another conceptualisation of science parks is forwarded by Kaukonen and Nieminen (1999), who suggest that universities, on their own or in collaboration with government and/or industry have created science parks that attempt to create a supportive or 'entrepreneurial' infrastructure for the region. This infrastructure is comprised of the facilities and services present within a given geographical area that encourage the birth and development of new enterprises and promote knowledge transfer from academia to industrial and commercial use.

The role of business incubators and science parks have arisen partly in response to the need of new enterprises to access resources locally and often at an affordable rate of exchange. According to Teece (1987) new enterprises may require varying levels of complementary assets depending on the type of innovation, market and sector and paying market prices for required resources – labour, knowledge, materials/equipment, facilities, etc. – is often inhibitory.

Literature also identifies a proliferation of various types of *regional support programmes* for stimulating the formation of new technology ventures in many countries. Amongst the best known are the Austin Texas incubator and the industrial cluster programmes of the Basque Country (Spain).

One example of a regional innovation initiative is the Innovation Relay Centre (IRC)⁷, established by the European Commission in 1995. One justification for creating the IRC, among others, is data demonstrating that technology transfer and innovation exploitation is low in comparison to the United States. In total the network has 68 IRCs with links to local companies and research institutions, 250 partner organisations and more than 1,000 specialist staff involved across Europe. The network also provides a channel to transfer technologies and know-how to new markets anywhere in Europe.

The IRC network has become a leading European network for the promotion of technology partnerships and transfer mainly between small and medium size

⁷ (http://www.ircscotland.net/about_irc/european_network.cfm).

companies (SMEs). However, it is evident that IRC provides more of a technology transfer role rather than creating local networking capabilities. IRC promotes the availability of innovative technologies to other organisations and companies through licensing, joint venture and manufacturing agreements, or commercial agreements with technical assistance.

6.2.3 Regional Support Networks

David Rosenberg, in his book “Cloning Silicon Valley” (2002), provides evidence that virtually every developed country in the world today is building or aspires to build its own innovation region using California’s Silicon Valley as an example. Regional initiatives, such as the Regional Innovation Strategies of the European Union, are focused on creating conditions that facilitate new enterprises and the successful exploitation of commercially applicable innovations. Creating regional conditions is expected to make a sustained difference to regional economic development in the medium term (North and Smallbone 1996).

The stimulation of ‘*support networks*’ is identified as a growing strategy designed to create and develop a supportive infrastructure for high technology companies, or an “entrepreneurial infrastructure” (Porter 1990). Networking as an intervention strategy is based on entrepreneurial network theory that suggests that strength, complexity and diversity of business relationships influence newly formed firm performance, resulting in improvement of the longer term chances of firm survival and growth (Shahidi 1998).

Similarly, the literature on “industrial districts” forwards the argument that there are a certain number of invisible factors which are favourable to economic development, such as the constitution of networks and the development of confidence and close relationships between firms (Tremblay 1998).

Malechi and Todtling (1995) assert that network creation is a growing policy prescription for regions where networks have failed to emerge. They found that regional economic development agencies in many countries globally have invested public money into schemes to facilitate and strengthen particular kinds of local networks in the belief that these support local competitive advantages and give rise to additional capital investment, employment and higher new business birth-rates.

Previous literature on regional entrepreneurship and network theory establishes that learning and innovation are often very localised. Efforts to strengthen the characteristics of effective and dynamic innovation systems are occurring at the regional level – for example the types of linkages that can be built between academic research, social partners, business support organisations and the individual firm, with particular emphasise on the needs of new enterprises.

However, Saxenian (1990, 1994) stresses that regional collaboration must be considered in the context of the region's social, cultural and historical background, cautioning that attempts to emulate Silicon Valley must take these many characteristics into account. She argues that these factors influence the nature of technical expertise networks in the region that promote entrepreneurial flexibility and perhaps limit the transferability of the model to other regions.

6.3 INTERVENTION IN SCOTLAND

Much has been made of *Silicon Glen*, Scotland's high technology corridor between Edinburgh and Glasgow that claims to have the highest concentration of high technology companies in the world outside of Silicon Valley. Watson (1999) points out that Scottish public officials began efforts to attract foreign technology companies in the 1960s with regional government grants and successfully secured a host of American and Japanese multinationals. By the early 1990s, electronics had displaced whiskey as Scotland's top export and in 1998, Scotland attracted 87 foreign high technology projects involving investment of £1.7 billion.

Recently, criticism has grown in Scotland regarding the make-up of the country's industrial base and perceived over-reliance on manufacturing plants - established by multi-national inward investment - and the low number of high-growth small and medium sized (SME) indigenous companies.

Part of the problem suggested by Downes and Eadie (1996) is that large multi-national corporations do not undertake research or development activities in Scotland, while the propensity and ability of SMEs to engage in significant levels of R&D is limited. Indeed, Hamel and Prahalad (1994) argue for the regional presence of small start-ups and large corporations existing symbiotically in developing a sustainable technology sector, with each requiring and drawing on the unique capabilities of the other.

Capell (2002) argues that the volatility in the global technology industry is exposing the weakness of Scotland's economic policy that he suggests is built on winning foreign investment at the expense of developing home-grown industries. Recently, large corporations such as Motorola and NEC Corporation have shut their Scottish plants and shifted production to Asia and Eastern Europe⁸. Job losses at Silicon Glen between 2000-2002 have been estimated at 15,000--more than 20% of the area's workforce. In 2002, the Scottish Executive announced that the Scottish economy, unlike the rest of Britain, was in recession.

Capell suggests that the main problem is that Scotland, home to 5 million people, depends more heavily on exports than does the rest of Britain. He cites the example of electronics, which makes up 51% of Scotland's overall exports. The plants in Silicon Glen shipped out \$3 billion worth of goods in the first quarter of 2002—down 16.3% from the same period last year.

The low level of SMEs and new start-ups in Scotland and the strategic importance of supporting new enterprise creation in technology-based sectors have been a high priority topic of debate in Scotland for some time. Research for Scottish Enterprise

found that creation and growth of new companies in Scotland is under-performing in comparison to England and other regions of the European Union, despite an impressive track record of Scottish high technology innovation and research (Scottish Enterprise 1993). One key recommendation from this research was biasing assistance for start-ups in favour of the “wealth-creating” sectors such as manufacturing and computer software (Gallagher, Kidd and Miller 1995).

The Scottish Business Birth Rate strategy was introduced by Scottish Enterprise in October 1993, aimed at improving the birth rate and early development of new firms:

“To compete, companies will need to build strong partnerships through which information and ideas can flow quickly and to best mutual advantage. Spanning customers, suppliers, competitors and other supporting institutions such as the universities, colleges, research bodies and the utilities, these specialist networks or ‘clusters’ create more of the sparks that fuel innovation and generate synergies that power them to greater competitiveness” (Scottish Enterprise, 1996:1).

This strategy also acknowledged that there were problems with existing networking agencies within the Scottish economy, and argued the need to encourage the effectiveness of both formal and informal networking arrangements. Further research cited by Scottish Enterprise (1993, 1996) compared hi-tech new ventures in Massachusetts and Scotland and found that, in Scotland, there was little networking between industry and research staff in academia and government laboratories. This research concluded that networking, mutual support and encouragement were low.

Other comparative research has demonstrated poor supportive agents for technology-based entrepreneurship. A low technology culture in the UK is suggested by Murray and Lott (1995) who found that UK venture capitalists impose stricter criteria on technology-based enterprises than on non-technology investments. Ennew and Binks (1993) found differences between Scottish and English banks in the perceptions of small businesses and suggest that Scotland seems to have a more extreme set of rules and social mores in determining support and advice.

⁸ Capell (2002) states that Silicon Glen’s assembly-line workers earn an average of \$1,300 a month, approximately ten times more than their counterparts in China.

Additional studies on the Scottish economy have found a lack of venture capital and inadequate mechanisms for investing in small firms, a shortage of small firm management expertise in strategic high-technology sectors, a lack of interaction and common purpose between academia and industry, and a weak ‘entrepreneurial culture’ (Collinson, 2000, Danson, 1996, Reid, 1997, Scottish Enterprise 1999).

Influenced by various research findings, Scottish Enterprise - the government agency charged with promoting Scottish industry - began focusing a number of programs with outside agents playing more of a facilitating role. The model is reflected in Figure 6.1.

Figure 6.1: The Entrepreneurial Process
(Scottish Enterprise, Top Teams in Growing Companies, 1999: 7)

<i>The Traditional Model</i>	<i>The ‘New’ Model</i>
Picking winners	Self Help
Training	Learning
Experience	Entrepreneurship
One-to-one	Networking
Counselling	Mentoring
Hands-on	Facilitating
Planning/Strategic	Innovative

Although support mechanisms such as Enterprise Allowance Scheme (EAS), Business Start-up Scheme (BSUS) have been abandoned in England, various focused support programs are facilitated or delivered through Scottish Enterprise. One example of a program reflecting Scottish Enterprise’s new strategy is Targeting Technology Ltd (TTL), based in Glasgow, that delivers Innovation Relay Center (IRC) services in Scotland. TTL is a publicly funded company that also provides a comprehensive mentoring service covering all aspects of developing a business based on innovative technology for Scottish start-ups. It also has advisers with

specialist expertise in managing intellectual property and intellectual assets within organisations.

A key justification for supporting technology exploitation in Scotland is the high level of internationally recognised scientific and technology-based research emerging out of Scottish universities and research institutions (Downes and Eadie 1996). Institutions such as Edinburgh's Roslin Institute and Scotland's research-intensive universities – Edinburgh, Glasgow, Dundee, Strathclyde, Aberdeen and Heriot-Watt – are particularly strong in innovations in fields of biomedical and lifesciences, electronics, software and oil and gas, among others.

The propensity to establish new technology-based enterprises to exploit university research includes the abilities and motivations of academics and the role of technology transfer offices that may not be compatible (Downes and Eadie 1996). Constraints to academic commercialisation can be traced to deeply rooted academic cultures, the research assessment exercise (RAE) that awards academics for research publications and departmental resource allocation regimes (Gascoigne and Metcalfe 1999).

Recent public schemes in the UK, such as the University Challenge Fund, suggest that there is more to do in commercialising university research and have contributed significant funding for university enterprise creation. Since 1999, over £45 million has been made available through 15 seedcorn funds to provide 37 research institutions (30 universities and 7 institutes) access to investment capital. According to recent data (European Venture Capital Journal, Sept. 2001) over 310 new enterprises have been spun out from the 37 institutions since July 1998, representing a three-fold increase compared to previous spin-out activity from these same institutions.

It was described earlier that a university is one of the elements in the support structure to create and develop new enterprises (Walshok 1994; Maleki 1997; Botham and Eadie 1997; Downes and Eadie 1996). Another element is the wider

commercial environment that comprise investors and those funding technology-based enterprises, small to medium-sized enterprises or corporations that may collaborate with universities, legal, management and marketing service providers and other public-private agencies that exist in the region to promote and support the development of start-up enterprises. Related to creating a regional support structure is the capability and inclination of the existing local industrial base to interact effectively with the academic research community.

The identified need for a ‘critical mass’ of particular knowledge and expertise in Scotland that links academia with industry to support new technology-based enterprises provided initial justification for the program *Connect Scotland* – the regional enterprise support network that is the focus of this thesis.

6.4 EVALUATING INTERVENTION PROGRAMS

There is considerable debate over intervention and support programs and the need and effectiveness of such initiatives. While difficult to quantify, the quality and the value added by support initiatives reflect great variation from country to country, and even from location to location in a given country (Lalkaka and Abetti 1998).

Much evaluation research has arisen from a rather narrowly based concern to ensure that public programme represent “good” value for money. Many evaluations are concerned fundamentally with assessing the success or failure of programmes (Rossi *et al* 1979). Few evaluations are able to provide definitive evidence regarding ‘success’, mainly because of the complexity of methodological issues that confront researchers, according to Gregory and Martin (1998). Success may be determined in absolute or differential terms. The measurement of impacts present particular problems because of the way in which evaluators adopt various definitions of what constitutes success, i.e., job creation, firm growth or firm survival rates.

Deakins *et al* (1998) notes that research on business development support programmes is too often carried out retrospectively; giving little or no opportunity to compare the differences that such support has made to the objectives and managerial ability of clients involved in the programme of support. In the same vein, studies of support programmes have pointed to a consistent lack of internal monitoring and information-gathering mechanisms that make it very difficult to evaluate results and impacts.

Rossi *et al* (1979) note that a critical first step prior to designing and implementing any intervention strategy is to verify that a problem exists in sufficient degree and extent to warrant an intervention. They argue that an evaluation methodology for any intervention programme requires a defined purpose as well as scaleable and appropriate assessment objectives. Different organisations may have different motives for undertaking and commissioning evaluations. Public accountability may emphasise a cost-benefit analysis and level of performance measurement for programme delivery.

Alford (1998) stresses that evaluators require high quality primary data, and it is rarely assembled adequately by the programme administrators. Few programme evaluations have included both qualitative and quantitative measures of 'process-oriented' outcomes and as a result some evaluators have found themselves unable to advise on improving programme design to enhance effectiveness (Gregory and Martin 1998). Individuals and groups may require evaluation systems that continually audit the delivery of services and their outcomes, and provide evidence of effectiveness to aid in their decision-making (Rossi, Freeman and Wright, 1979).

Patton (1990) points out that process evaluations are aimed at understanding the internal dynamics of programme operations, and typically require a detailed description of programme operations. Process analysis asks how the programme works with emphasis on identifying ways of improving programme design and delivery, and is typically qualitative in approach (Cook and Reichardt 1979). A process evaluation requires sensitivity to both qualitative and quantitative change in

programmes throughout their development, and means becoming intimately acquainted with the details of the programme (Patton 1987).

Patton (1990) suggests that process evaluations permit decision-makers and information users to understand the dynamics of programme operations, shedding light on the extent to which the programme is operating the way it is supposed to be operating. They are also useful for revealing areas in which programmes can be improved as well as highlighting those strengths that should be preserved.

Patton cites two other uses of process evaluations. They permit people not intimately involved in the programme, external funders, public officials and external agencies, to understand how the programme operates. As well, they are particularly useful for dissemination and replication of programmes under conditions where a programme has served as a demonstration project or is considered to be a model worthy of replication at another site.

Establishing effectiveness and credibility and improving a program's delivery and process are seen as important challenges for most evaluations. An analysis of the evaluation literature concerned with support programmes shows that there are at least four major criteria to be fulfilled in a process evaluation (Rossi *et al* 1979; Patton 1990; Gregory and Martin 1996). These are:

1. An evaluation methodology for any support programme requires a defined purpose as well as scaleable and appropriate assessment objectives in terms of both process and outcomes;
2. A process evaluation requires sensitivity to both qualitative and quantitative change in programmes throughout their development, and means becoming intimately acquainted with the details of the programme;
3. If the results of an evaluation are to gain widespread acceptance and credibility in the public domain, it is essential that a full range of stakeholder perspectives be incorporated into the research design. This suggests incorporating a measure of

the 'value' that stakeholders perceive from exposure to the programme, and preferably how that perceived value changes over the time of the programme.

4. If a phenomenon under investigation is complex, information-rich cases are useful in learning a great deal about issues of central importance to the purpose of the evaluation. This is difficult to achieve and requires a level of analysis that focuses on each company (micro-firm level).

Literature identifies particular issues in evaluating intervention at the regional level. Charles *et al* (2000) identify challenges of evaluating a regional innovation and technology transfer strategy and infrastructure scheme (RITTS) that include *overlap* among service suppliers. They suggest that an evolutionary view of evaluation emphasise 'relative' rather than 'absolute' impact changes, or *how far* improvements have been made from a starting position rather than *how much* impact has been achieved.

An identified problem in evaluating university spin-out enterprises is understanding the regional effects of other commercialisation actors and how these enterprises are commercially enabled and supported by the community that is external to the university (Walshok 1994; Downes and Eadie 1996).

Finally, identified in Chapter Six were evaluation issues related to networks and an identified underdevelopment of studies pertaining to the regional and intermediary dimensions of networking. These particular evaluation issues and use of networking as a regional intervention strategy for technology-based entrepreneurship will form the research issues taken up by this thesis, and will be described in Chapter Seven.

6.5 SUMMARY

This chapter identifies various intervention strategies undertaken to create the conditions characterising successful technology regions and to counter perceived commercial difficulties faced by new technology-based enterprises. Clusters,

incubators, and science parks are some of the mechanisms expected to improve the success for new enterprises and contribute to regional economic development. Critics of intervention argue that market forces must prevail, to ensure that only the competent and value-potential companies survive.

Implications from this literature to the research intent of the thesis identify the relevance of regional intervention to Scotland, a country deficient in many of the infrastructure conditions characterising successful technology regions but possessing a world-class science and technology base. Justification for intervention is based on research showing high rates of enterprise failure, poor networking between industry and academia and studies comparing Scotland with characteristics of successful innovation regions.

The appropriateness of a regional support network as an intervention strategy provided justification for the creation of Connect Scotland. However, literature identifies various methodological challenges in evaluating the effectiveness of intervention programs in general that include the consistent lack of internal monitoring and information-gathering mechanisms, the need for longer evaluation time-frames to allow effects on technology enterprises to emerge, post-mortem evaluation and the lack of scaleable and appropriate assessment objectives. Challenges for evaluating networks include the informal nature of networks, attribution of effect problems and difficulties in separated overlapping effects among different networks and support influences. Few studies have looked at regional support networks as an intervention strategy.

Evaluation literature suggests the need to identify and describe the network support structure and potentially overlapping support influences that establish the regional support context. Identifying network attribution effects on technology enterprises requires a longer-term approach to evaluation. Taking the network, technology enterprises and support agents within the regional support structure as units of inquiry could provide a descriptive, functional and attributable assessment of active regional intervention support given the evaluation issues described in this chapter.

CHAPTER SEVEN

RESEARCH DESIGN - BUILDING AN APPROACH TO EVALUATING A REGIONAL SUPPORT NETWORK

7.1 INTRODUCTION

This chapter identifies key research issues from the literature, builds a research argument and describes the research design and methodological approach for this thesis. Research issues draw on socio-economic explanations of technology-based entrepreneurship and justifications for intervention mechanisms such as formal networks for stimulating the conditions that characterise successful innovation regions.

The research argument centres on evaluating a regional support network for technology entrepreneurship in the UK – *Connect Scotland* – its creation, formation and growth, impact and value to participants and role among other regional support initiatives¹. The chapter describes a pilot study of Connect that fine-tunes the action research design, identified as most appropriate when studying change, when the researcher is a participant in the change process and when an intervention technique is being evaluated. The constituency-building model is described that identifies for evaluation purposes the multiple elements of the network.

A description of the empirical research includes: network and stakeholder analysis; perceived value of the network as judged by stakeholders; case studies that reveal how network value is realised and drawn into processes of enterprise formation and growth; and complementary support initiatives and regional external factors identified by network stakeholders that affect network activities and outcomes. The final section of the chapter describes the data collection processes and research limitations.

¹ The methodological implication of using a single network as the research case will be discussed later in the chapter.

7.2. SUMMARY OF RELEVANT LITERATURE

Literature review identifies high priority given to technology-based entrepreneurship by public and private sectors – e.g. corporations, universities, regions and nations – to improve competitiveness, counter decreasing public funding support and diversify the regional industrial base, among other factors.

A social system perspective suggests that innovation and entrepreneurship are often collective achievements for countering the uncertainties, complexities and risks in commercialising technology innovations (Kline and Rosenberg 1986) that include lack of resources and capabilities, such as knowledge, investment and managerial expertise. Knight asserts that the ‘gamble’ in undertaking production under uncertainty can be socialised by collective ownership of the means of production. Similarly, Schumpeter emphasises that it does not matter that *innovations* or ‘new combinations’ and *functions* are carried out by the same people who control the productive and commercial processes (1934).

A social systems framework describes the collective efforts of interdependent actors in common pursuit of outcomes (Mowery 1985; Nelson 1982) that includes the entrepreneur as an active ‘change agent’. Outcomes of these effort evolve *through the accretion of numerous institutional, resource and proprietary events that co-produce each other over an extend period* (Van de Ven 1993: 212). Van de Ven argues that the inter-organisational community or network is a relevant unit of analysis if one aspires to understand the factors that contribute to entrepreneurial outcomes.

Molina’s *socio-technical constituency* approach considers the sources of knowledge, expertise and other factors that facilitate technology development and exploitation within a particular constituency. This approach suggests that various elements – human, material and financial – are in a constant state of flux, and are influenced by activity external to the constituency as well. Molina emphasises the continual evolution of constituencies and the importance of interactions and knowledge

exchange across socio-economic networks and the influence of key institutions and their inherent interest groups.

Social theorists further argue that the spread of innovations and commercial success is a function of the support that can be drawn into new ventures from the larger community as well as industry conditions. Research on corporate entrepreneurship describe the importance of social capital and social networks in gaining support and legitimacy as well as in securing necessary resources to exploit new opportunities within existing companies (Kanter 1985; Burt 1987). Literature on academic entrepreneurship suggests that most universities rely on external support from public and private sources to secure investment, provide market diligence of technology, secure professional management and supply channels among others.

Literature on national systems of innovation, regions, clusters and networks describes the conditions under which enterprises are created and flourish. The concept of the 'entrepreneurial infrastructure' (Vaughn 1983; Porter 1990) emphasises the convergence of roles and activities that contribute to the creation, development and growth of enterprises. The achievements of technology regions such as Silicon Valley, Route 128, and the Boston area have resulted in regional policies and programs from less successful regions attempting to imitate these successful ones (Rosenberg 2002).

In the case of Scotland, support initiatives have emerged to counter research evidence and generally held perceptions that Scotland has a low entrepreneurial culture, low levels of infrastructure support and a low birth rate of new companies (Storey 1994, Collinson 2000). Drawing on many of the concepts and perspectives described above, the identified need for a 'critical mass' of particular knowledge and expertise to stimulate regional technology entrepreneurship is behind justification for the network-based program *Connect Scotland*.

7.2.1 Issues from the Literature: Networks as a Regional Intervention Strategy

Literature identifies limited research on networks as a regional intervention strategy. Although there is comprehensive literature on network theory, much of it is based on exchange and dependency relations within or between *existing* organisations or on structural characteristics such as network size, density, strength of ties (Monge and Contractor 1999).

The application of network theory to regional support networks is made difficult by the various definitions, dimensions and variables used in network analysis. Literature suggests that there are many 'types' of networks serving different functions: formal and informal networks (Birley 1985), information, exchange and influence networks (Johannisson 2000), service, assistance and product development networks (Monsted 1993) and innovation and business networks, among others (Bundall and Smith 2001).

Network researchers identify the need to further explore how networks are formed, how they develop and evolve and their focus and effectiveness (e.g. Burt 1992; Hakansson and Johanson 1993; Saxenian 1994; Walker *et al* 1997). Grandori and Soda (1995:184), for example, argue that the understanding of the initial stages of network development is particularly lacking.

Few studies have examined networks as an intervention program and their effects on improving the conditions to emulate 'successful' technology regions. This includes identification of various private-public roles and the activities and levels of interaction between them - in effect a level of regional entrepreneurship - and the determination of how these roles and activities manifest themselves as benefits for new and emerging enterprises. For example, although universities are prominent in regional efforts to exploit innovations, an identified problem in research on university-based enterprises is the lack of a theoretical basis in understanding how enterprises are created and supported by the outside community (Autio 2000).

The management dimension to networks identifies the role of co-ordinating network activities and intermediating in the resource exchange between network actors (Burt 1987; Casson 1997). Questions arise over the type of networks that are formally managed and evaluation of network intermediation activities and assessment of impact that has ‘value for money’ implications, common features of many *public* program evaluation. This issue calls into question the use of various measurements to determine network ‘success’, i.e., job creation, company growth or survival rates. These measurements may not be identified as networking objectives, or the network objectives being measured may be too broad to capture actual program effects².

Overall, there appears to be a need to establish more clearly what a regional support network is and how it makes a difference in supporting the exploitation and commercialisation of technology-based opportunities (e.g. Rangan 2000). Establishing network benefits is challenged by evaluation difficulties in attributing network benefits on the enterprise (e.g. Birley 1985; Aldrich and Zimmer 1986; Aldrich *et al* 1987; Venkataraman 1989; Dubini and Aldrich 1991; Larson 1991; Larson and Starr 1993). Evaluation issues include accommodating the evolving nature of networks over time and justifying and establishing the unit(s) of analysis – e.g. network, region, enterprise, entrepreneur and knowledge creator.

7.3 RESEARCH QUESTIONS AND INTENT

Three sets of research questions are proposed from the above background. The first set of questions is focused on network theory and practice as it relates to regional support networks. What is a regional support network, how is it created, and what are its management and operational characteristics? What benefits do a regional enterprise support network provide to network participants and to what extent? How does this network change over time as suggested by evolutionary network theories?

The second set of research questions relates to network effects on new technology

² Connect San Diego, operating since 1985, has only recently begun to formally evaluate its impact and effects.

companies – the primary targeted beneficiary of most intervention initiatives and for Connect Scotland. What specific commercialisation difficulties are faced by new technology companies that justifies the need for support and what benefits are attributed to involvement within the network? Are benefits of a network-based support initiative similar to network benefits identified in other studies, e.g. social capital effects, knowledge transfer, business credibility, access to resources not held internally, etc.

The third set of research questions is focused on the role of the Connect network among other regional support initiatives. What is the role of Connect with universities, seed funding schemes and other initiatives and how are these complementary elements perceived by network stakeholders and used by technology companies? How does the Connect network function as an element of a regional or national system of innovation?

In addition to the three levels of research identified above, practical insights regarding support networks are expected to emerge as research results unfold.

Connect Scotland is identified as a relevant case for exploring the multiple interrelated questions arising from the literature. Since Connect Scotland commenced operations in 1997, there has been a perception by Connect stakeholders, staff and others that Connect is fulfilling its aims and objectives. However, these impacts and outcomes have not been monitored or recorded on a structured basis. This is primarily because the Connect program itself has lacked the resources to pursue such activity. Its main focus has been on building the national network.

Ellaram (1996: 100) claims that a single case study can be used to “*test a well-informed theory, an extreme or unique case, or a case which represents a previously inaccessible phenomenon*”. Although other support networks, such as Connect San Diego, were considerations for comparative study, ‘national’ network support programs similar to Connect Scotland were not identified.

7.3.1 ‘Pilot Study’ of Connect Scotland

A pilot study was undertaken in 1999 using as a guideline six quantifiable targets (Table 7.1) that were established for Connect’s first 4 years of operation, 1997-2000. These targets focus on three themes: number of events and audience mix (stakeholder attendance to events); number of technology companies securing development/growth funding; and number of spin-out companies, collaborations and associated jobs created.

From Table 7.1, it can be seen that the nature of the committed targets increases in difficulty as one moves down the table. Delivering a specific number of events, for example, is much easier than demonstrating that a minimum of 180 new high income jobs were enabled by Connect. Yet any evaluation of these targets would be expected to account for both.

Table 7.1: Quantifiable Targets for Connect’s Outputs and Impacts
(up to end of year 2000)

Key Indicators	Quantifiable Targets
No. of events held	-At least 162 events; minimum of 25 participants per event; target mix is 50% technology ventures; 30% academics and 20% business professionals
No. of technology ventures participating in events	-At least 180 new and emerging technology companies will attend the mix of workshops and briefings; <i>-Learning achieved will significantly enhance the ability of participating companies to increase their rate of sustainable growth</i> -Quality target is 75% of participants to rate the event as “good” or better on a scale measuring the perceived value of the event to the business/individual
No. of collaborative projects	-At least 216 academics/research staff will attend the mix of events -At least 45 collaborative projects between technology ventures and university/research centres to be established in the project period
No. of technology ventures securing funding	-At least 40 technology companies will secure developmental/growth funding <i>-Pilot has already established that technology ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance</i>
No. of spin-out companies formed	-Connect will facilitate and enable the creation of 15 spin-out companies from the Scottish science base and established technology companies <i>-Participation in Connect is likely to improve the survival and growth rate of any spin-out company</i>
No. of new jobs	-Minimum of 180 new high income jobs enabled by Connect

The pilot study experienced limitations³ on available data and information that could determine only two of six 6 key indicators in Table 7.1. The study also identified that more challenging targets (i.e. funding, spin-outs and employment) were related to building a support network and that evaluation of these targets was perhaps premature. Research suggests that evaluation early in the lifetime of a program may be misleading, as the full scale of program impacts may not yet be evident (Segal *et al* 1985).

Indeed, Connect CEO Ian MacDonald acknowledged that direct benefits to private sponsors (i.e. gaining new clients from network involvement) may not be evident in the short-term in 1997 by stating, “...*From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years.*”

The pilot study generated the question of whether or not economic impact targets were appropriate since Connect Scotland does not pursue formal and systematic mentoring of new technology-based companies. Measuring these targets would require isolating ‘contributions’ from network actors, attributing them to formation and investment outcomes as well as defining what the terms ‘facilitate’ and ‘enable’ are meant to imply. These quantitative measurements would assume a static, equilibrium-based analysis where the enterprise and contributors are rational entities engaged within relative network structures⁴.

Literature suggests that network effects are often cumulative and consequently difficult to measure. Output targets in Table 7.1 do not provide insights into network processes, cause and effect relationships of social interaction and business exchange among network actors or any credible measure of network effects on technology

³ Quantitative analysis of event, attendance and audience mix targets was made difficult by a lack of readily available data. Although Connect had maintained a record of attendance to each event, this information existed on individual *Microsoft (MS) Excel* forms and thus needed to be transcribed to *MS Access* in order to formulate totals and determine patterns of activity by stakeholder category. Similarly, membership data needed to be formulated to determine active versus non-active stakeholders, company sectors, key company contacts, etc.

⁴ This approach would incorporate quantitative research methods and reduce the evaluation to quantitative indicators that are more easily integrated into economic models. Although policy-makers will often demand quantitative data for the purposes of prediction and the ‘political need for numbers’ will win through the researchers best intentions (Easterby-Smith *et al* 1991: 105), this approach would still require assumptions and predictions of network effects that would limit validity and reliability.

companies during the formation phases when they are expected to be most active in the network. Of key interest is the social structure element of Connect that is missing in any quantitative evaluation.

This thesis will argue that the Connect network can be conceived as a *sociotechnical constituency* encompassing the interrelation and interactions between key players supporting the transformation of technological innovations into new enterprises. Network actors are constituents seeking interaction to provide and acquire a variety of resources and capabilities with the network itself shaping and being shaped by the actors and their interactions. Molina suggests that the interests, expertise and power held by different actors in the constituency shape the development of a given technology (Molina 1990, 1995, 1998). This could apply as well to the social shaping of a network.

Evaluating an evolving phenomenon comprised of multiple structural elements and social processes suggests a holistic perspective to discover key categories, dimensions and interrelationships rather than testing theoretically derived (deductive) hypotheses (Patton 1990). The strategy of inductive designs allows important analysis dimensions to emerge from patterns found in the cases under study without presupposing in advance what the important dimensions will be.

7.3.2 Post-Pilot Methodological Considerations

Based on pilot study findings, further methodological considerations are forwarded. Evaluation of Connect as a case subject will draw upon a well-developed sociotechnical constituency theory (Molina 1990, 1993, 1995, 1998) that strengthens the argument for a single study. As Stake suggests (1994: 242) “*generalisations from differences between any two cases are much less to be trusted than generalisations from one*”.

The research will adopt an *action research* design, identified as most appropriate when studying change, the researcher is a participant in the change process and/or one is evaluating an intervention technique (Foote Whyte 1991; McKernan 1991). Action research is also appropriate for limitations in theory and practice that require flexibility to accommodate issues of topicality, uniqueness and usefulness while following sound research methods that generate acceptable theoretical insights (Mone and McKinley 1993). Action research can also establish different perspectives on program processes for the purpose of improving such programs (Silverman 1993). A key concept in action research, according to Robson (1993), is that the research does not end with interpretation or theoretical understanding.

The strong social structure component of networks suggests a design that can explore the often 'tacit' component of knowledge, that 'resides in people' (Vincenti 1990) since network theory and practice emphasise that networks are social structures comprised of multiple actors. The level of social engagement inherent within a network and the desire to assess perceptions and gain information and insights from others is particularly well suited to placing the researcher within the research environment.

Therefore, a participant observer approach will be undertaken that allows the author to position himself for research purposes within Connect to gain access to knowledge, perceptions and other insights as both the network and its actors evolve over time.

In keeping with the spirit of action research, this thesis will adopt a 'real-time' approach to evaluation by regularly informing the program for the purposes of improvement. Evaluation, according to Posovac and Carey (1997) can facilitate program improvements when discrepancies are noted between what is observed and what was planned, projected or needed, when adopting a logical sequence between needs, processes, outcomes and efficiency.

In this regard, evaluation of Connect will not be an arms-length “*post-mortem*” evaluation but rather one where the evaluator becomes part of the ‘learning factor’ as the evaluation progresses. The role of the researcher provides a ‘real-time’ factor contributing to the development of the program by making explicit achievements, difficulties, challenges and weaknesses, with the results fed back into the evolving Connect constituency to inform and improve the program. This methodological approach provides a practical application to this research and for other network-based programs that face similar evaluation challenges.

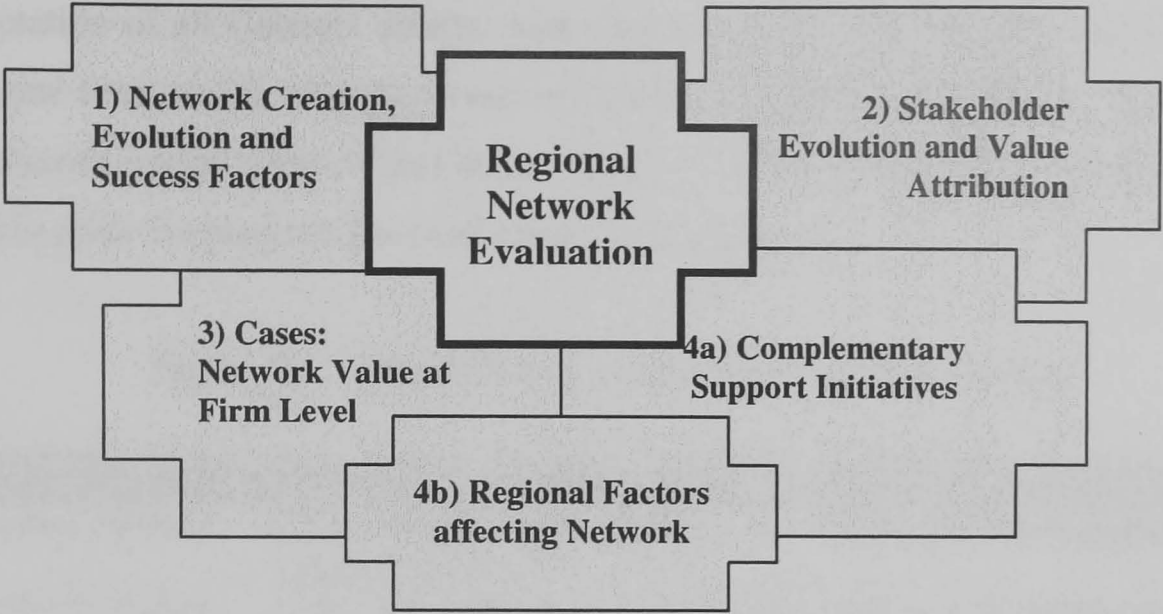
Finally, in considering the longitudinal character of this proposed research, process evaluation guidelines are appropriate for ongoing assessment of perceptions of people, the context or ‘milieu’ where they are found and the less understood social processes in operation (e.g. Bulmar 1986; Silverman 1993). Guidelines include: 1) defining the original intent of a program for all stakeholders and a description of program activities; 2) identifying growth or change throughout the program; and 3) including a full range of stakeholder perspectives if evaluation results are to gain widespread acceptance and credibility in the public domain (Rossi *et al* 1979; Patton 1987; Gregory and Martin 1996).

7.4 RESEARCH DESIGN

7.4.1 Levels of Analysis

The research incorporates complementary units of analysis to address the three sets of research questions, as Figure 7.1 shows: 1) the network; 2) its stakeholders; 3) the primary intended beneficiary of network efforts, technology companies; 4a) complementary support initiatives; and 4b) external factors affecting the network and support for technology entrepreneurship.

Figure 7.1: Integrated Levels of Analysis: An Action Research Approach to Evaluating Connect Scotland



Network analysis begins with the origins and development of the Connect program and describes its events, activities and mechanisms. Program evolution and key success factors examine how a change in June 2001 to Connect’s funding structure has affected network activities and benefit delivery. As mentioned earlier, network growth by itself does not explain the level of interactions and connections among and between stakeholders, types of value exchange occurring or the value and effectiveness of the network in general. Insights in network membership retention levels identify factors affecting attraction to the network and network disengagement.

Stakeholder analysis looks at the value-added delivered by the Connect program with reference to its original objectives and judged by its stakeholders. Measuring effectiveness and attributing value to the network is made difficult by the nature of the Connect’s indirect role. As mentioned, Connect has no *direct* control of processes leading to new or increased numbers of collaborative projects, spin out companies, or new jobs.

The pilot study identified the difficulty of measuring direct attribution to Connect. This prompted the question on whether or not network benefits or value gained by stakeholders in attending recurrent events could be deconstructed for purposes of measurement.

Three value flows were identified from Connect’s own objectives -social, knowledge and financial value flows. Table 7.2 shows that knowledge value is an overriding expectation of all Connect events, with financial value also pursued explicitly. At the same time, social value is central to Connect’s mandate with the expectation that interactions, social contacts and the building of relationships between people are the starting point for business-focused activity and outcomes.

Table 7.2: Value Focus of Connect’s Core Events

Type of Event	Objective	Value Focus
Technology briefings	To enhance understanding and facilitate technology transfer	Knowledge/social
Enterprise Workshops	To develop the general management skills of both technological entrepreneurs and entrepreneurial technologists	Knowledge/social
Meet the Entrepreneur (“An Audience with”)	Learning from the experience of others and discussing development of their own businesses	Knowledge/social
Springboard Workshops	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations	Knowledge/social
Investment Conference	To provide the opportunity for technology companies seeking finance to present to an international audience of investors.	Finance/knowledge/social
Partnership Conference	To assist in the exploitation of the research through partnerships, joint ventures, new company creation	Knowledge/Finance/social

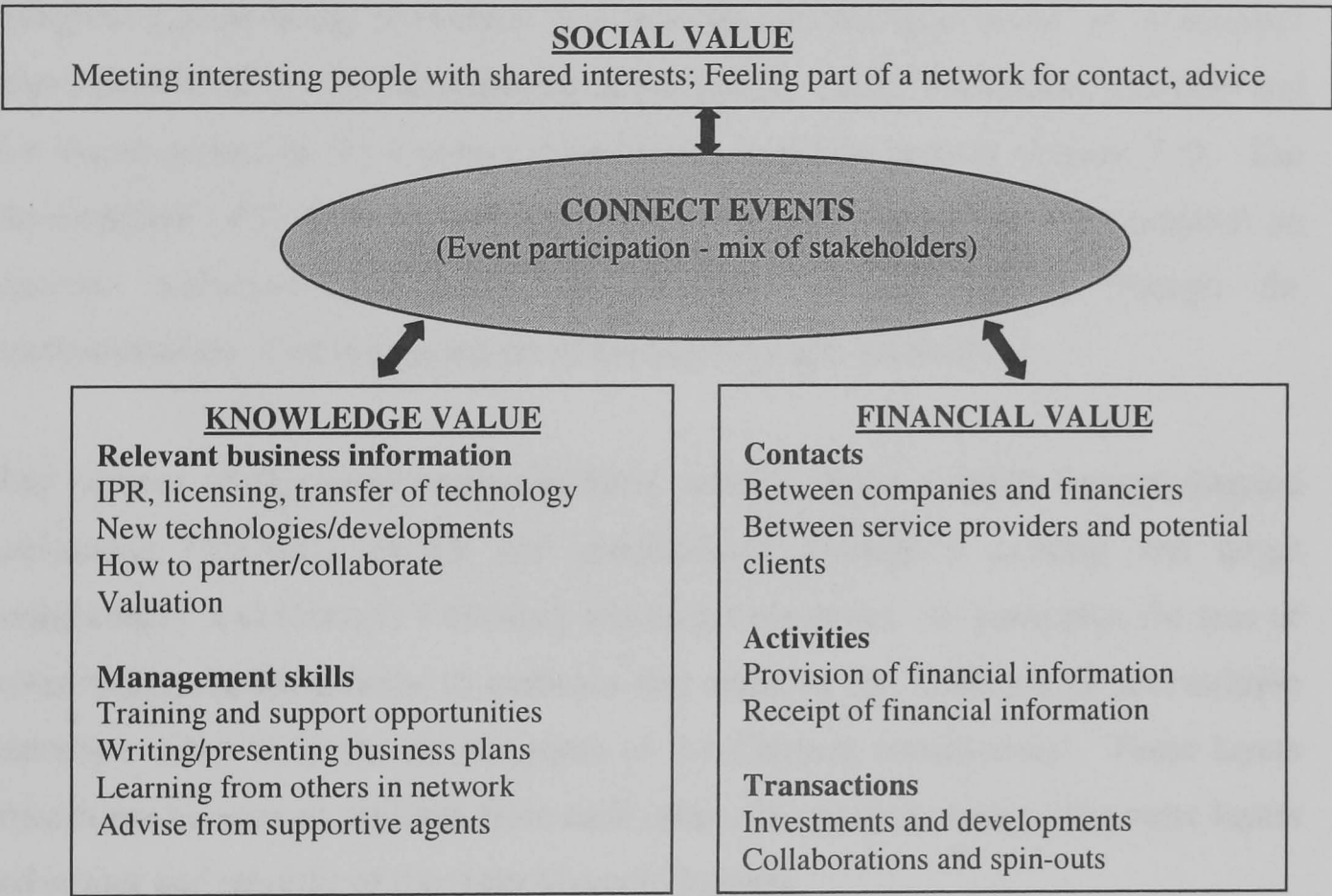
The specification of three dimensions to measure network value is based on explicit objectives of each of the recurrent events with *social*, *knowledge* and *financial* value provision as common themes. Each of the three value flows is decomposed into topics aimed at capturing a gradation of impact or value added by Connect as perceived by the program’s stakeholders.

The resulting topics are listed in Figure 7.2. From these topics, a total of 20 indicators were chosen for the three value dimensions, with each indicator rated using a modified Lickert scale⁵. The value survey can be found in Appendix A. The objective of the survey is to evaluate where Connect has been beneficial to all

⁵ To avoid sample bias, sample selection involved two different samples of similar stakeholder groups using the same survey and 20 indicators. Guidelines were followed from Child (1990), who argues that samples need to be taken from a homogeneous population, as factors may be specific to each population. He cautions that crossing populations requires an interpretation that defines attributes appropriately. Sampling is discussed in Appendix B.

stakeholders, not simply technology companies, regarding social and business contacts, gaining or giving relevant knowledge, and attracting or providing financing for member companies. A further intention of the value survey is to assess whether or not this value is changing over time. The sampling process for the two value surveys, 1999 and 2001, is outlined in Appendix B.

Figure 7.2: Social, Knowledge and Financial Value of Events



Case study analysis identifies a cross-section of technology companies active in the Connect network to capture evidence of actual effects of the Connect program on early-stage formation processes and provide some cross-industry validation of network effects. In acknowledging that there is no generally accepted set of performance measures to evaluate new enterprises (McGee and Dowling 1994), interviews with company founders identify formation challenges, commercialisation difficulties. Four of the six case studies involve interviews with two or more founders to temper respondent bias.

Analysis of complementary support initiatives and regional factors identified by stakeholders qualify Connect's role, activities and effects during the course of the research and informs the practice of regional intervention initiatives from the point of view of intended beneficiaries and those managing the initiatives.

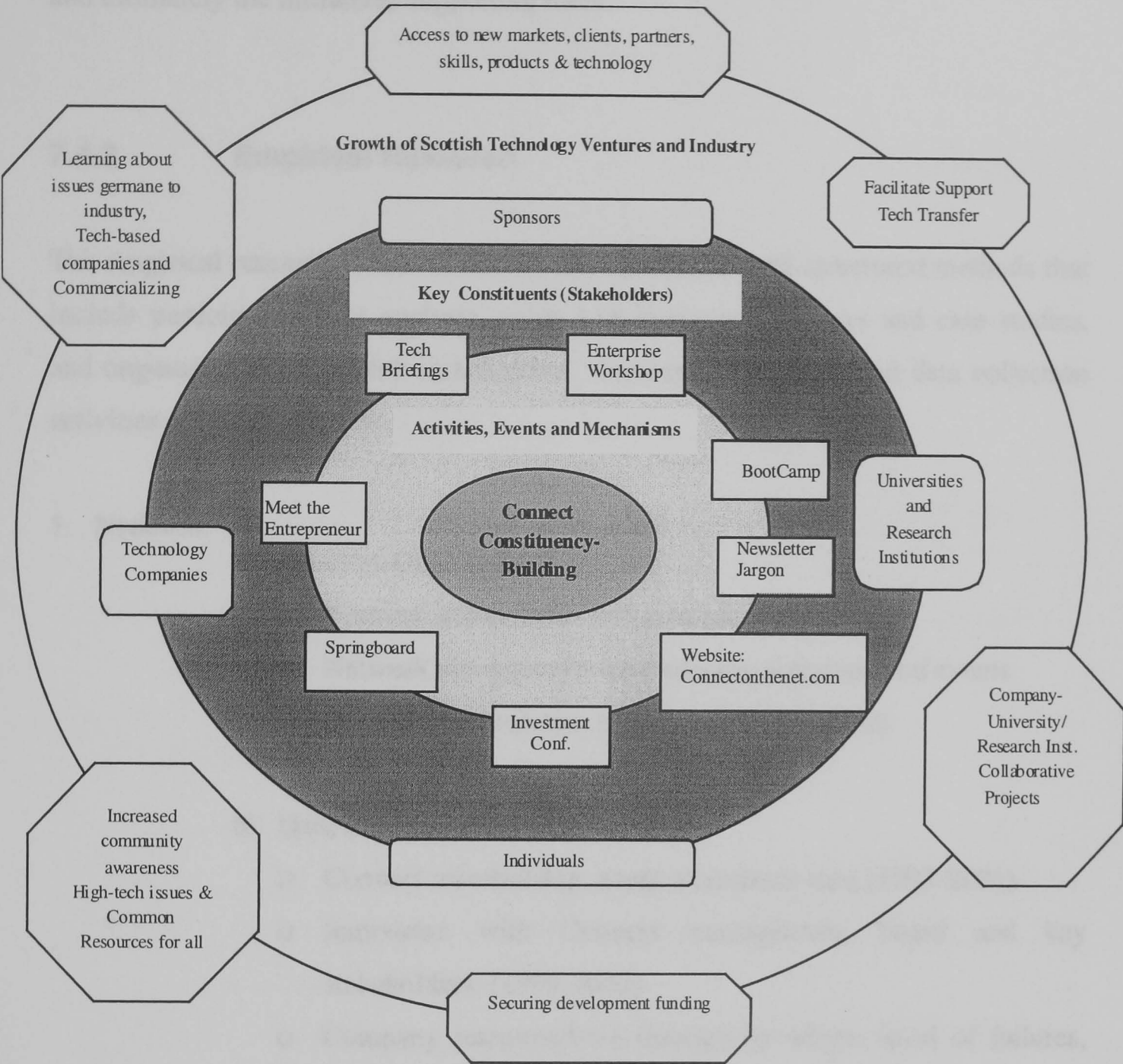
7.4.2 Constituency-building Model

Integrating these levels of analysis is a '*constituency building model*' or 'conceptual lens', developed to accommodate the development, value, weaknesses and potential for improvement in the Connect constituency-building process (Figure 7.3). The development of Connect is seen as a process of constituency-building targeted on specific audiences and intent on achieving defined targets through the implementation of an integrated set of mechanisms and activities.

The content of this constituency-building process shows a multi-layered diagram containing Connect's events and mechanisms, Connect's existing and target stakeholders, and Connect's existing and target outcomes. In particular, the lens of constituency-building helps to partition and organise the treatment of the multiple elements involved in the development of the Connect constituency. These layers should not be seen as separate from each other. In practice, each of the outer layers subsumes and requires of the inner layers to happen.

In Figure 7.3, the circle at its centre represents the focus of the evaluation, namely, the entire process of Connect constituency-building for the purpose of supporting the creation, development and growth of technology-based enterprises throughout Scotland. The first layer around the core shows the main activities, events and mechanisms through which the Connect constituency-process is realised.

Figure 7.3: Network Constituency-Building Model



The second layer around the core shows the key constituents or stakeholders, either present or targeted by the activities, events and mechanisms of the Connect programmes. The third and final layer around the core shows the target results expected to lead to the ultimate mission of growth of Scottish technology ventures and industry. These outer layer targets reflect the ‘interface’ between Connect Scotland, complementary support initiatives and public and private activities as these targets can be considered as common contributors to the economic goals for the region. Beyond these layers can be conceived external factors and conditions that

‘permeate’ these layers and affect, in particular, markets and technology companies and ultimately the initiatives supporting them.

7.4.3 Empirical Research

The empirical research involves various structured and semi-structured methods that include participation data analysis, value and investment surveys and case studies, and ongoing interviews with stakeholders. Research objectives and data collection activities are shown below:

1. Network:

a) Analysis Objectives:

- ☐ Network justification and creation
- ☐ Network management mechanisms, activities and events
- ☐ Growth and evolution of network (1997-2002)

b) Data Collection:

- ☐ Connect membership, event attendance data (1997-2001)
- ☐ Interviews with Connect management, board and key stakeholders: (1999-2002)
- ☐ Company retention/flow-through by sector, level of failures, spin-outs versus non-spin-outs

2. Stakeholders:

a) Analysis Objectives:

- ☐ Original stakeholder expectations
- ☐ Level of network activity (event attendance)
- ☐ Stakeholder perceptions of network value (social, knowledge, financial) at two points in time, quality of events and overall perceptions of Connect Scotland
- ☐ Retention/flow through of stakeholders

b) Data Collection:

- ❑ Assessment of explicit stakeholder benefits
- ❑ Stakeholder membership data (1997-2001)
- ❑ Value surveys (1999 and 2001; n=116)
- ❑ Random interviews from among sample of survey respondents in 1999 and 2001 (n=52)
- ❑ Investment survey (1997-2001; n=35)

3. Technology Companies:

a) Analysis Objectives:

- ❑ Value 'transfer' from network to companies
- ❑ Regional 'enablers and constraints' to commercialisation

b) Data Collection:

- ❑ 6 cases studies of technology companies active in network
- ❑ Survey feedback from technology companies

4. 'Complementary Initiatives' and Regional Factors:

a) Analysis Objectives:

- ❑ Identification and assessment of related regional mechanisms and factors identified from previous levels of analysis

b) Data Collection:

- ❑ Scottish Enterprise (SE) and Proof-of-Concept Fund
- ❑ Edinburgh Technology Fund
- ❑ Scottish Research Institutes (Roslin Institute)
- ❑ Scottish Institute for Enterprise

Descriptions of research processes can be found in the following appendices:

- ❑ Appendix A: network value survey
- ❑ Appendix B: value survey sampling
- ❑ Appendix C: key stakeholders interview schedule
- ❑ Appendix D: interview format
- ❑ Appendix E: list of survey respondents interviewed
- ❑ Appendix F: investment survey results
- ❑ Appendix G: letter to case study companies
- ❑ Appendix H: interview format: post-spin-out
- ❑ Appendix I: description of seed funding schemes

7.5 METHODOLOGICAL LIMITATIONS

Attribution of network effects remains a research limitation in identifying, assessing and measuring Connect's direct impact on targets of new company creation (spin-outs), collaborations and job enablement. One reason is that causal relations for these types of outcomes are influenced by factors beyond the direct impact of the activities and mechanisms of the Connect constituency-building process.

The effects of complementary support initiatives will be identified in the research as they relate to the experiences of Connect stakeholders. Regional economic factors that influence the network and the creation and growth of technology companies will also be identified as they relate to network stakeholders. However, the effects of technology market conditions and the impact of public policy has not been directly examined and is assumed to be a significant variable affecting Connect's technology company members, although issues related to Scotland's industrial structure is considered in Chapter Eleven.

For the value survey, further statistical measures beyond cross-tabulation are not incorporated because the research focus is on an exploratory comparison of perceived value to distinguish results between stakeholders and between two points in time. Cross-tabulation of survey results contain dependent variables (social, knowledge and financial dimensions and 20 indicators) and independent variables (public, private sponsor, university, technology company, individual/other category).

This research approach identifies with a reflection by Bechhofer (1974:73) who states: *"the research process, then is not a clear cut sequence of procedures following a neat pattern, but a messy interaction between the conceptual and empirical world, deduction and induction occurring at the same time"*. This research approach also supports the claim by Karl Mannheim, who cautions that one cannot understand the diversity of beliefs and standpoints in society unless one explores and analyses the range and diversity of its group life (Levine 1959).

7.6 SUMMARY

This chapter described the research focus and methodological approach to be taken in this thesis. The research is based on identified conceptual, theoretical and practical gaps in understanding the creation, evolution and effectiveness of formal support networks, made difficult by the evolving nature of networks over time and lack of definition of units of analysis – e.g. network, region, enterprise, entrepreneur and knowledge creator.

A study of a regional enterprise support network, Connect Scotland, provides the research case. The research establishes four central levels of inquiry. First is an examination of the creation and evolution of the network itself - its justification, mandate and objectives and Connect Scotland's mechanisms, activities and events used to enhance regional connectivity.

The delivery model of Connect Scotland is examined - taking into account that Connect has evolved from a university-based enterprise support network program to a private company and is one amongst other support programs in Scotland focused on technology commercialisation. Exploring Connect's network management model is undertaken to determine its affects on network processes and value delivery to stakeholders and to inform the evolutionary network model debate.

The second level of inquiry examines Connect stakeholders within the network. Active stakeholders are surveyed between 1999 and 2001 to capture social, knowledge and financial value perceptions implicit in Connect's program mandate and activities and to examine how this value is evolving over time. Stakeholders are interviewed to further examine their perceptions of Connect, recommendations for improvement and issues facing technology entrepreneurship in Scotland.

The third level of inquiry examines the value of the network to new technology-based enterprises – the stakeholder group of central importance to the network. In addition to the value flows identified above, a survey of companies that presented at

Connect's investment conference over four years establishes more measurable financial value attributable from the network. Case studies provide a more in-depth and descriptive assessment of Connect's value to enterprise formation processes and inform the debate on how regional factors enable or constrain early stage technology companies in the Scottish context.

The fourth level of inquiry examines complementary support initiatives and regional factors identified during the research as factors affecting the evolution and impact of the Connect Scotland network.

In short, empirical research includes assessment of network event and participation data over 5 years (1997-2001); two value surveys, in 1999 and 2001 of 116 stakeholders and an investment survey of 35 presenting companies; 6 cases studies of early-stage technology companies, interviews with 52 stakeholders and examination of other support mechanisms and regional factors affecting Connect and its stakeholders.

CHAPTER EIGHT

NETWORK AND STAKEHOLDER ANALYSIS

8.1 INTRODUCTION

This chapter provides results that examine Connect's first 6 years (1997-2002) following the constituency-building framework. The first section describes the Connect network: its creation and formation, objectives, network management mechanisms and activities and events. The second section examines Connect's growth and development up until it became a private company, in June 2001¹, that includes its transition from pilot project to national network program achievements of its original four-year program targets (1997-2000).

The third section examines Connect stakeholders, beginning with membership growth and retention patterns and insights into why stakeholders enter and leave the network. Results of the 1999 and 2001 surveys describe sponsor, university and technology company perceptions of event quality, social, knowledge and financial benefits they attribute to Connect and provide general comments and recommendation on Connect's effectiveness. Results of the 2001 investment survey identify tangible and intangible value directly attributed to Connect's investment events.

¹ Chapter Eleven examines Connect one-year after it evolved into a private company and the discussion at the end of this chapter concerns results up to June 2001.

8.2 DESCRIBING THE NETWORK OF *CONNECT* *SCOTLAND*

8.2.1 Creation and Early Development

The creation of Connect Scotland is a story of transfer of entrepreneurship. In 1995 Ian MacDonald, on staff at the University of Edinburgh Management School and involved in research on support programs, perceived that a similar style of organisation to a US-based model - *Connect San Diego* - could play a significant role within the Scottish business arena. Connect San Diego was created in 1985 at the University of California, San Diego and had developed one of the most comprehensive business support networks in the US.

At the time, a number of important differences existed in adopting the San Diego model for a similar program in Scotland. A stronger entrepreneurial culture, greater supply of investment, larger critical mass of new companies, SMEs and larger corporations characterised the region of San Diego. Different objectives and expectations would need to be considered in addition to the fact that Connect San Diego has been operating for a decade.

From this context, Ian suggests that in 1995 there were fundamental issues not being addressed in Scotland regarding supporting new technology companies, creating a gap between the actual needs of technology companies and existing support programs. These issues included the development and growth of a support network of people common to high technology regions and the development and growth of a Scottish-based supply of investment. In particular, management skills and good networks were seen as necessary to get the resources and know-how that entrepreneurs require to create and develop companies.

The concept of a Connect-like program conformed to one of the key themes in SHEFC's 1995 Corporate Plan, namely, "to develop the responsiveness and vitality of the research base in Scottish higher education, and to work with higher education institutions and other agencies in contributing to economic competitiveness and the quality of life." More

specifically it conformed to a critical objective within this theme, “to develop further links between Scottish higher education institutions and industry and commerce.”²

Most importantly, the development of a Connect program in Scotland was a central recommendation given in the Technology Ventures strategy document published on 28 August 1996. Technology Ventures’ broad aim is to establish new businesses and jobs within Scotland and is based at Scottish Enterprise. Technology Ventures itself was created as a result of a Commercialisation Enquiry conducted jointly by the Scottish Office and the Royal Society of Edinburgh.

This document built on the earlier Commercialisation Enquiry conducted by Scottish Enterprise (SE) and the Royal Society of Edinburgh (RSE) and identified a wide range of factors requiring attention to help nurture a technology ventures culture and economy in Scotland. It also proposed avenues to tackle the problem, amongst them, the establishment of a networking and business support infrastructure to generate effective academic-industry links facilitating the multi-directional flow of information between academia, companies and service providers.

The document identified Connect at the University of California, San Diego as “an appropriate model”³, stating that the development of Connect in Scotland constitutes a clear answer to this recommendation and the “vision is to create and develop a programme that will have an impact in Scotland similar to that of the Connect programme in San Diego.”⁴

² Request for Funding from SHEFC to Support the National Development of the Connect Programme (1997)]

³ The document described UCSD Connect as follows: “Run from the University of California San Diego and funded by the private sector, it promotes the development of the region’s high tech industries and the commercialisation of the University’s research. It creates networking opportunities, stimulating the flow of ideas and knowledge between the academic, business and financial communities, and offers business development services assisting, for example, companies to obtain finance and academics to commercialise their research. Within the high tech community it acts as a hub, linking local and global networks.” (RSE/SE, *Technology Ventures: Commercialising Scotland’s Science and Technology*, Scottish Enterprise, Glasgow, 1996, p.22) The perception exists that similar conditions to San Diego would apply in Scotland, thus making possible the potentially successful implementation of a Connect programme in Scotland.

⁴ MacDonald and Ritchie, 31st October 1997, p.4.

In 1996, a proposal was submitted to the Scottish Higher Education Funding Council (SHEFC)⁵ for the start of a pilot program of activity and events initially focused on the Lothian and Fife region. In this 1996 proposal, it was made clear that the intention was for the activities of Connect to be eventually extended to other regions within Scotland. This intention was realised through a further proposal in 1997, with the result that the programme expanded nationally to become Connect Scotland.⁶

Connect was originally conceived in 1995 to be an Edinburgh-focused program that would be informal and low key. CEO Ian MacDonald concedes that there was not an initial expectation to plan a Scottish national programme to support technology companies although there was evidence that a national programme was needed. Although Scotland is well-recognised for its technical creativity, there was evidence (discussed in Chapter Six) of a low entrepreneurial culture in Scotland and low levels of technology-based start-ups in comparison to other regions of the UK, Europe and America.

The initial challenge for Connect, according to Ian, was to get people in Edinburgh to sign up to a program based on the premise that “we are going to do something which is useful, will you pay for it”? Awareness of Connect as a program and brand was non-existent and the first primary challenge was to establish a critical mass of private sector sponsors. One of the first people Ian sought for consul and discussion on the concept was Martin Ritchie, one of Scotland’s most successful Scottish entrepreneurs whose support, Ian believed, would provide initial credibility in developing a supportive infrastructure in this critical early stage.

Martin Ritchie’s decision to take on the role of Connect’s Chairman provided Connect with critical management and leadership capabilities and access to a far-reaching business network. Ian affirms that Martin was key in establishing a core of 20 founding private sponsors and dealing with numerous public and private organisations to promote the concept of Connect.

⁵ MacDonald, I., *Connect – The University of Edinburgh Programme in Technology and Entrepreneurship*, 29 May 1996. Proposal to SHEFC detailing the background, mission Statement, key stakeholders, programme administration and activities, resource requirements and funding.

⁶ MacDonald, I. and Ritchie, M., *Connect – National Development Proposal*, 31st October 1997.

Public sector support from the University of Edinburgh was identified as another key factor further enhancing Connect's early credibility. In their 1999 interviews, both Ian and Martin allude to the critical support from Sir Stewart Sutherland, the Principal of the University of Edinburgh, who saw the value of Connect not only for the university but also for Scotland.

A critical mass of both private and public sponsors was quickly secured in 1996. Scotland's larger research-led universities (Glasgow, Strathclyde and Heriott-Watt) followed Edinburgh's lead and signed up as Connect sponsors, thus 'pulling' the other Scottish universities into the network quite quickly. Connect West Director Dr. Andrew McNair suggests that other universities did not want to miss out on new commercialisation opportunities related to their technologies, and the establishment of a Connect network with a base of Scotland's top universities as public sponsors compelled remaining universities to join the network.

The successful creation and early development of Connect in Scotland cannot be attributed to one particular factor. Certainly a broad public support base for the Connect concept was important – particularly from Technology Ventures, the Royal Society of Edinburgh, the Scottish Education and Industry Department and the Scottish Higher Education Funding Council. Direct support from the University of Edinburgh was a significant factor while early private sector support and business contacts initiated by Martin Ritchie secured a critical mass of private-sector sponsors.

Another significant creation factor was the entrepreneurial vision and drive of Ian MacDonald, first in generating interest for a Scottish Connect based on the San Diego model and second, in convincing key private and public actors to join and assist with their spheres of influence. Professor James Fleck, School of Management Director at the time of Connect's creation, argues that Ian MacDonald's determination in the face of 'considerable early uncertainty' and his willingness to forego an academic career to start Connect cannot be underestimated as a factor in Connect's successful formation.

8.2.2 Connect's Mission and Objectives

Since its inception in 1996, Connect has maintained the following mission:

“To support the creation, development and growth of technology-based enterprise throughout Scotland”.

This mission required that Connect bring together multiple actors in different regions of Scotland that include universities, sponsors, entrepreneurs and companies. Connect's mission followed the rationale that interaction between these communities is critical for the development of high growth and high technology enterprises⁷. It also followed the findings and recommendations of enquiries and policies of key Scottish industrial and academic institutions, including Scottish Enterprise, SHEFC and the Royal Society. Connect remains the only national network programme focused on high technology companies.

To a large extent Connect Scotland set for itself a fundamental challenge for this Scottish knowledge economy namely to stimulate a resource and expertise environment for interaction, learning and opportunities for different communities interested in the development of technology-based ventures and, ultimately, economic growth. Bridging of the knowledge gap existing between these different communities is central to this purpose and relates to Connect's key objectives, as explained below.

1. Develop and educate an expert infrastructure that understands and supports the needs of technology-based ventures, giving companies access to networks of expertise and resources essential to their success in a global market-place;
2. Facilitate and support the transfer of technology from the Scottish science base to new and existing firms, either by spin-out or through collaborative projects;
3. Complement specific initiatives in individual agencies and organisations, providing a resource which can be used by all participants to promote and develop related activities and projects;⁸
4. Enhance the ability of new and existing firms to secure finance;

⁷ See Connects Request for Funding from SHEFC to Support the National Development of the Connect Programme (1997).

5. Educate entrepreneurs about business development and issues germane to their industries;
6. Help entrepreneurs to define new enterprises and whether to start them.

8.2.3 Network Events and Activities

Connect's mission and objectives are to be achieved through a program of formal events facilitating and encouraging interactions between communities sharing a common interest in supporting technology entrepreneurship. These communities include the university sector, large corporations, emerging technology ventures and existing companies, service providers, regional government, economic development agencies and support groups.

Figure 8.1 identifies six formal events designed by Connect to facilitate exchange between the *people* from these communities: entrepreneurs, technologists and scientists, technology transfer personnel, banks, equity capital providers, business consultants, accountants, lawyers and policy-makers, among others.

It is through attendance and participation at these events that the majority of Connect stakeholders are expected to interact. Connect's events are therefore used to stimulate a resource and expertise environment for interaction, learning and opportunities for these different communities interested in the development of technology-based ventures.

⁸ From the beginning Connect has made it clear that the aim is not to compete with established activity but to provide a channel for all participants, in particular research institutions and technology companies, to access skills, expertise, resources which already exists throughout Scotland.

Figure 8.1: Connect Events and Activities

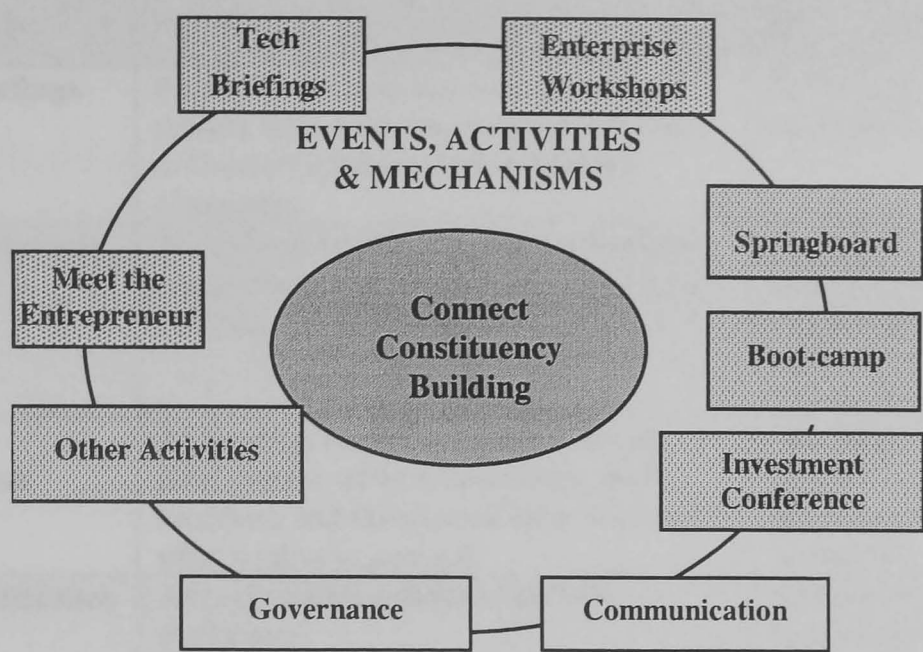


Table 8.1 describes each of these six events and their objectives. Each event is expected to play a specific purpose for specific stakeholder audiences and they together combine to fulfil Connect’s objectives that include bridging the knowledge gap existing between these communities.

8.2.3.1 **Recurring Events**

The first three events in Table 8.1 are *recurring* types of events that are central to Connect’s national constituency mandate: *technology briefings*, *enterprise workshops* and *meet the entrepreneur* events. These events are delivered primarily at four locations: Aberdeen, Dundee, Edinburgh and Glasgow and, of major methodological importance, the thesis argues that the majority of the Connect constituency (sponsors, companies, others) come together at these three events. Therefore, it can be argued that development of the Connect constituency and the identification of stakeholders’ participation can be derived from patterns of attendance to these 3 events.

Table 8.1: Event Descriptions and Objectives

Event Type	Description	Objective
Technology briefings	Forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies.	To enhance understanding and facilitate technology transfer
Enterprise Workshops	Workshops bringing together technology companies and researchers with advisors and business professionals	To develop the general management skills of both technological entrepreneurs and entrepreneurial technologists
Meet the Entrepreneur	Technology entrepreneurs discuss the development of their businesses, their successes and failures and their views of what it takes to succeed.	Learning from the experience of others and discussing development of their own businesses
Investment Conference	Annual venture capital investment conference	To provide the opportunity for technology companies seeking finance to present to audience of international investors
Springboard (pre-investment workshop)	Forum for individual/businesses to present, in confidence, their technological concepts, proposed business strategy or business plans to an expert panel	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations
Boot-camp	Two-day course focused on twenty to thirty companies, providing preparation for the investment conference	To provide a series of experts to discuss core subjects; i.e. routes to market, refining the technology proposition
Other Events	National program kick-off in Glasgow, Annual Corporate Partnership Conference, Breakfast meetings	Events created to respond to specific needs of Connect as they emerge

8.2.3.2 Investment Events

Connect delivers three integrated investment events that support technology companies in becoming investor-ready and attracting investment and section 8.4.4 of this chapter examines benefits realised by companies from the investment conference.

The “Investment Conference”, first delivered in 1997, is considered Connect’s ‘flagship’ event with 25 new and emerging technology companies presenting their business propositions each year. This conference is unique in Scotland as the only investment forum exclusive to new technologies and had developed into an attraction for investors from the UK, other countries of Europe and the US and Canada.

Since 2000, after Connect had run 3 Investment Conferences, the “Springboard” Workshop was created to specifically focus on companies seeking early-stage financing. Connect found that early stage companies presenting at the Investment Conference had developed to the point that these same companies came back looking for second round funding or pre-IPO funding. Connect saw the need for creating a ‘sister event’ to the Investment Conference to focus on stimulating the development of ‘investor-ready’ companies leading up to the Investment Conference. Key objectives of Springboard include: creating a unique market-place for pre-start and start-up companies to present to an expert audience of technology angels, experienced entrepreneurs and business professionals; providing networking opportunities; and showcasing the best emerging technology companies in Scotland.

Springboard consists of formal 10-minute presentation sessions, after which presenting companies adjourn to breakout rooms to meet on a one-to-one basis with the expert audience. The criteria for applicants are pre-start and early-stage technology businesses who have not yet raised a first round of investment finance and are seeking the opportunity to present their business proposal to a qualified audience. There is no cost to presenting companies. Connect intends on offering more than one springboard a year as the business environment develops in Scotland. This includes the expectation of successful student entrepreneurs from the Scottish Institute for Enterprise (SIE) with technology backgrounds that want to spin business out.

A third and most recent investment event, “Boot-camp”, is similar to springboard as a preparation for the investment conference. Boot camp is a two-day course focused on twenty to thirty companies, providing a series of experts to discuss particular core subjects such as routes to market and refining the technology proposition. For example, the focus of 2001 boot-camp was product marketing and how to sell the business to potential customers or partners or investors. Boot camp sits at the post-seed stage - up to raising serious venture capital funding and showcases specific business issues.

These three investment events reflect a more ‘hands-on’ approach by Connect in supporting technology companies. A common theme of these investment events involves a

selection process using a sponsor-based selection committee. Connect then assists selected candidates in fine-tuning their business proposition at boot-camp and springboard in order to ensure that credible and compelling opportunities are presented to serious investors at the annual Investment Conference.

8.2.3.3 Other Activities

Connect provides 'other' events on an ad-hoc basis that includes breakfast meetings to discuss particular topics of interest and one partnership conference to recruit technology workers for new companies. Large flagship 'type' events have also been an important strategy for Connect in attracting people into the network. For example, when Connect expanded to the west of Scotland to develop a national network, a large event was held in Glasgow, attracting one hundred people, many of them key business leaders. Connect brought up speakers from Microsoft Cambridge and invited media and policy makers as well as existing members of Connect. Dr. Andrew McNair, Connect West Director suggests that other private sponsors, particularly legal and accounting institutions from the west, signed up as sponsors at this event.

8.2.4 Governance and Communication Mechanisms (to June 2001)

Connect's national mandate to support technology entrepreneurship has resulted in a formal structure of governance and communication for its events and activities. Connect's governance is based on a formal 'membership-based' model that generates fees to cover the costs of delivering events and activities. All *sponsors* – private and public - pay a £3000 annual fee to join Connect. Sponsors are entitled to sit on the Advisory Board of Connect and are involved in developing event topics for members.

Members are companies and individuals paying a small fee of £100 per year in exchange for access to Connects' events, receipt of the *Jargon* newsletter and the opportunity to

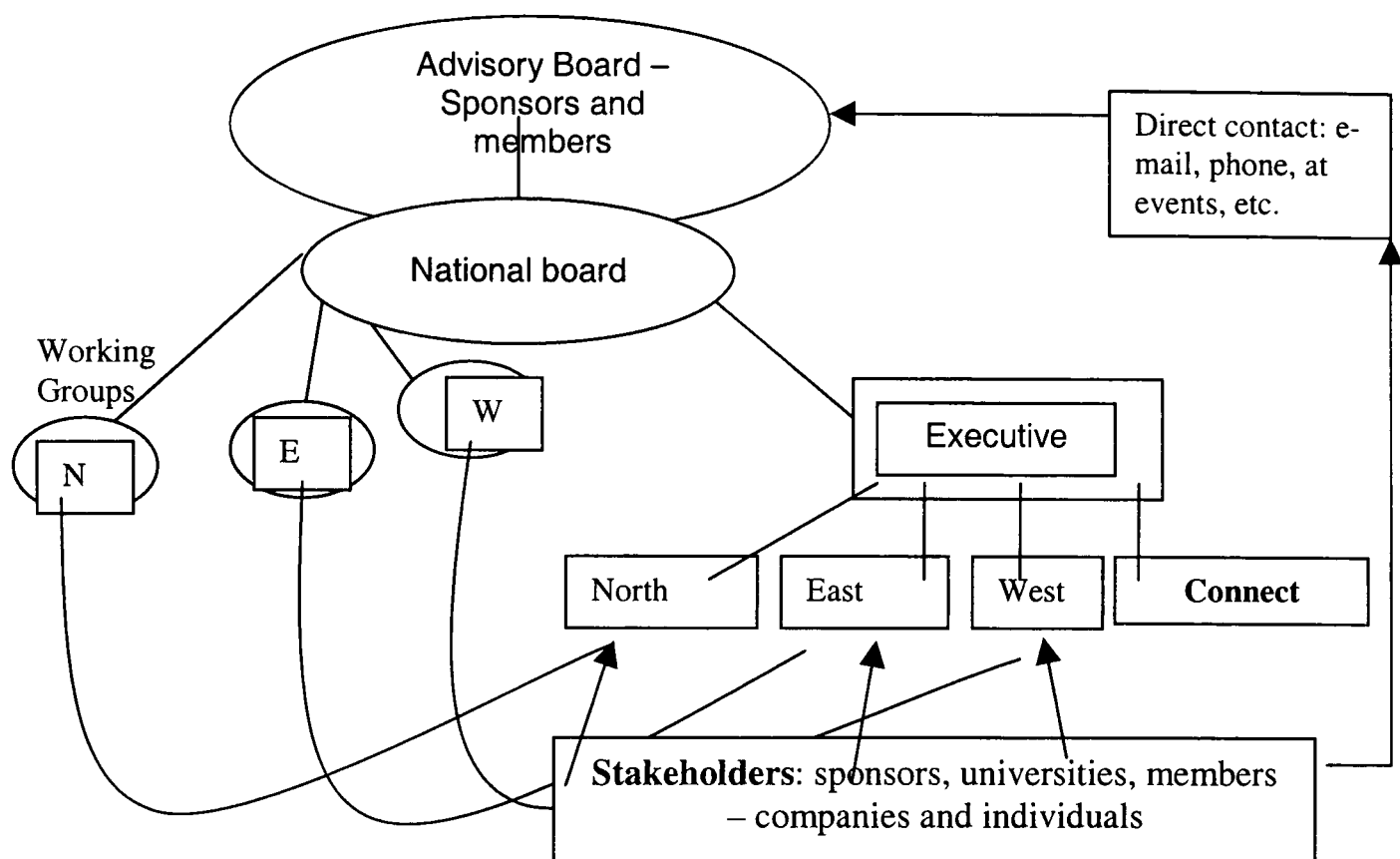
present their ideas at the Springboard event and Investment Conference. Individual members generally are those people with no organisational affiliation.

Since 1997, Connect has been operated by 5 full-time staff: CEO Ian MacDonald, three regional directors (north: Aberdeen – Susan Morrison; west: Glasgow – Dr. Andrew McNair; and east: Edinburgh – Ian MacDonald), Events and Sponsorship Director – Gillian Mayman and an office administrator. Regional directors are responsible for recruiting new company members and ‘plugging’ them into the network and event organisation. The directors also identify potential new sponsors for CEO MacDonald, who is the primary contact between Connect and its sponsors.

In addition to membership and event management, the Connect office administrator and Event Director also recruit new company members by scanning a variety of information sources relevant to new and emerging technology-based companies. These sources include the regional business magazines and newspapers, professional publications and newsletters. These efforts complement the recruiting activities of Connect’s regional directors who are more involved in one-to-one interactions and recruiting through third party introductions.

Figure 8.2 provides an approximation of the structure of the Connect network. Starting from the bottom right are all the stakeholders of the Connect constituency: sponsors, enterprises, individuals, etc. who are scattered across North, East and West of Scotland.

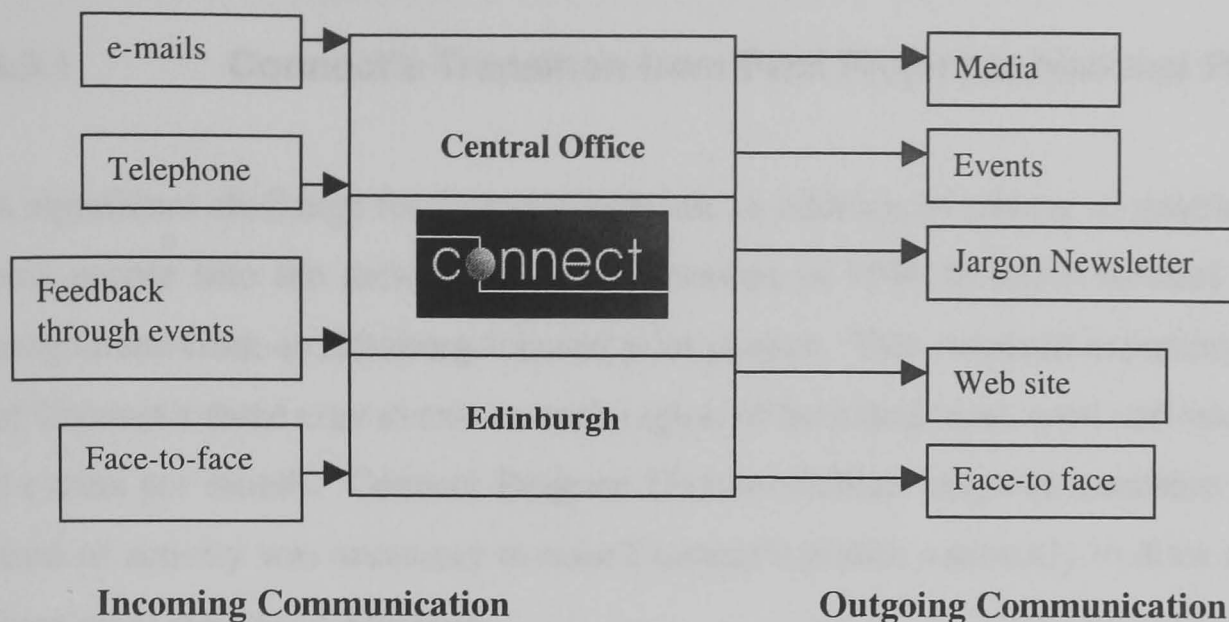
Figure 8.2: Connect’s Regional Network (to June, 2001)



Regional working groups, shown to the left of Figure 8.2, provide stakeholders with direct contact and feedback to the Connect Executive or National Board. Connect activities overall are guided by the Advisory Board, made up of sponsors and regional working group representatives who are instrumental in assisting Connect in developing event content and providing general advice.

Connect’s administrative office in Edinburgh is responsible for interfacing with sponsors, members and others linked to Connect (Figure 8.3). Communication between Connect and its network stakeholders up until 2001 was primary through its newsletter *Jargon* that kept sponsors and members abreast of ongoing developments in technology and information on upcoming events, workshops etc.

Figure 8.3: Network Communication Interface



After June 2001, this communication between Connect and its network will become more web-based (www.connectonthenet.com). The web-site, according to Ian MacDonald, will be designed to offer a complementary mechanism for Connect's approximately 1600⁹ active stakeholders – sponsors, members and others - to communicate outside Connect events and meetings. Approximately £100,000 is being set aside for the Connect web-site from Connect's ERDF programme to hire a database specialist for the office to formalise contact information and the profile of sponsors and members. The web-site will focus more on showcasing regional and external skills and expertise among the Connect network and provide customised and timely information and tools for its membership.

Leveraging the human capital that Connect has brought together and directing specific activities onto the website is expected to provide additional opportunities for the generation and dissemination of quality information to complement Connect events. CEO MacDonald expects Connect to develop performance targets for the website that will allow Connect to approach sponsors at the end of each year and assess their perception of its value and level of usage.

⁹ This estimate by the Connect central office (June 2002) accounts for those active sponsors and members, interested parties and others that have contacted Connect to request ongoing correspondence.

8.3 NETWORK GROWTH AND EVOLUTION

8.3.1 Connect's Transition from Pilot Project to National Program

A significant challenge for Connect early on, in addition to raising its profile and drawing new people into the network, was the decision in 1998 to move forward as a national programme from an Edinburgh-focused pilot project. This involved expanding the delivery of Connect's three core events to each region of Scotland (east, west and north), from 3 to 9 events per month. Connect Program Director Gillian Mayman concedes that this high level of activity was necessary to raise Connect's profile nationally to draw new people in from other regions of Scotland.

This national expansion had operational consequences for Connect, beginning with logistical issues: such as securing more venues for events, regional event promotion and ensuring that Connect staff would be in attendance at each event held in Dundee, Glasgow, Edinburgh and Aberdeen. High demands were placed on sustaining such activity with a small staff base while working to ensure that Connect's programme of events was fresh and there was a constant flow of high quality speakers.

A key operational issue for Connect at this time was the uncertainty in determining what skill-set to hire for the growing organisation. As Gillian Mayman states, all of Connect's directors had joined Connect with a 'clean slate', arriving with a mix of backgrounds and learning on the job as Connect developed. It became evident that Connect required a database to accommodate an expanding network membership base as this duty could not be undertaken by existing staff. A second Connect office secretary was eventually hired that could also set up and administer the database. Mayman concedes that a continual challenge for Connect is to balance network operational requirements with direct support for technology companies as there is no slack in staff time and internal resources.

CEO MacDonald suggests that his ability to manage excessive demands on staff has been challenged by his own workload and reliance on the autonomy of his staff in getting things done. Ian describes the managerial learning curve he continues to experience and the

balance required in managing his own activities and considering those of his staff. The combination of increased events and memberships, managing stakeholder expectations and raising the profile of Connect contributed to a significant increase in staff workloads.

Indeed, the ability of Connect to manage this growth phase can be attributed in large part to the competency and dedication of Ian and his staff that have together provided a high level of program consistency in promoting itself to the public and to prospective and current stakeholders. CEO Ian MacDonald has been with Connect since its inception, Gill Mayman has been involved since 1996 and Dr. Andrew McNair since 1998.

Another operational issue faced by Connect in expansion has been *regional inclusion* - i.e. ensuring that each region of Scotland is perceived as belonging to the network. As the greatest concentration of Scottish companies is in the central belt between Edinburgh and Glasgow, there is concern that northern regions (Dundee and Aberdeen) would not feel part of the national network. Practically, more travel has been required by northern stakeholder to attend Connect events, but in reality travel to events out of region has not been as prevalent as expected. Interviews with stakeholders and Connect staff identify that travel time is an attendance constraint for small company owners typically stretched for time. As well, lack of a familiar social network of people at distant events and less relevance to regional business issues are factors that may favour local network activities and support programs over attendance to Connect events.

Connect North Director Susan Morrison, based in Aberdeen, alludes to other issues facing Connect in supporting new companies in the north region. First, she contends that the angel investor community and professional advisor infrastructure is not as diversified as in the east and west, tending to be focused on oil and gas rather than other technologies. Morrison asserts that Connect's profile is higher in the central-belt of Scotland, partly due to the fact that there is simply more technology company success stories. Further, Morrison asserts that there is a large geographical area for her to cover, resulting in less time spent working with new technology opportunities and more time spent on administration and travel.

8.3.2 Network - Building Targets (1997-2000)

In building a national network for technology support, Connect set for itself a number of quantitative and qualitative targets to achieve in its first four years of operation, 1997-2000 (Table 8.2).

Table 8.2: ‘Network-building’ Targets (1997-2000)

Key Indicators	Quantifiable Targets
No. of events held and stakeholder mix	-At least 162 events; minimum of 25 participants per event; target mix is 50% technology ventures; 30% academics and 20% business professionals
No. of technology ventures participating in events	-At least 180 new and emerging technology companies will attend the mix of workshops and briefings; <i>-Learning achieved will significantly enhance the ability of participating companies to increase their rate of sustainable growth</i> <i>-Quality target is 75% of participants to rate the event as “good” or better on a scale measuring the perceived value of the event to the business/individual</i>
No. of collaborative projects	-At least 216 academics/research staff will attend the mix of events -At least 45 collaborative projects between technology ventures and university/research centres to be established in the project period
No. of technology ventures securing funding	-At least 40 technology companies will secure developmental/growth funding <i>-Pilot has already established that technology ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance</i>
No. of spin-out companies formed	-Connect will facilitate and enable the creation of 15 spin-out companies from the Scottish science base and established technology companies <i>-Participation in Connect is likely to improve the survival and growth rate of any spin-out company</i>
No. of new jobs	-Minimum of 180 new high income jobs enabled by Connect

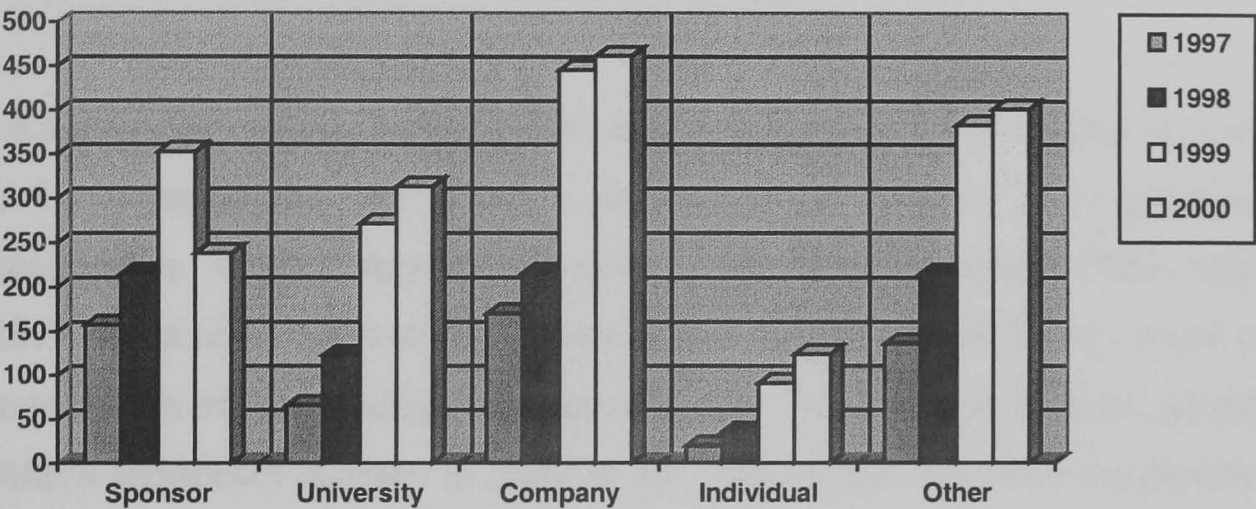
From Table 8.2, it can be seen that the nature of the committed targets increases in difficulty as one moves down the table. Delivering a specific number of events, for example, is much easier than demonstrating that a minimum of 180 new high income jobs were enabled by Connect. Results evaluating these targets are described below, beginning with indicators from the top of the table.

8.3.2.1 Event Attendance

Stakeholder attendance to recurrent events shows significant growth from all stakeholder categories (Graph 8.1) but growth was especially high between 1998 and 1999. This

reflects the fact that, during this time, Connect began developing the national constituency in Scotland. It should be emphasised again that the purpose of the recurrent events is to deliver specific knowledge from keynote speakers on relevant technology and business topics while providing a regional forum where the vast majority of Connect’s stakeholders will interact.

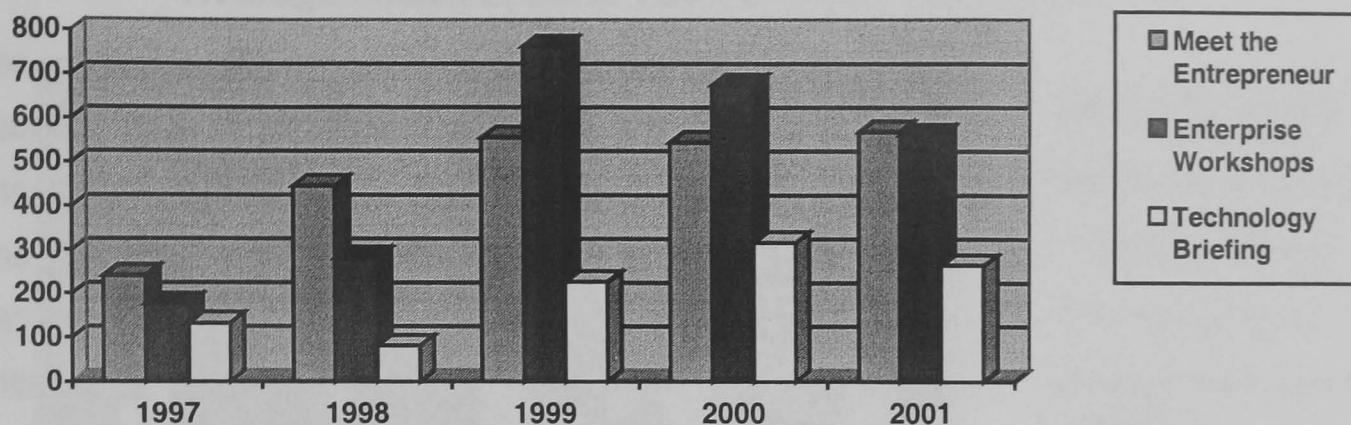
Graph 8.1: Stakeholder Attendance to Recurrent Events, 1997-2000



After the leap of 1999, attendance growth between 1999 and 2000 continued at a slower rate in all stakeholder categories, with the exception of sponsors who show a significant drop of 33%. These absolute figures however can be put in perspective, because during 2000 Connect Scotland ran 46 events as compared with 59 during the year 1999. Clearly, 13 less events go a long way to explain the relative slow down in growth, as shall be discussed below after seeing other figures.

Graph 8.2 gives another angle into the evolution of attendance patterns to the 3 recurrent events over the 4 years. It can be seen that ‘enterprise workshop’ attendance more than tripled (333%) between 1997 and 1999 and has dropped off by 11% from 1999 to 2000. ‘Meet the entrepreneur’ event attendance shows continuous growth of 130% between 1997 and 2000 and a slight drop off by 2% from 1999 to 2000. In contrast, ‘technology briefing’ attendance shows a drop of attendance early between 1997 and 1998 of 39%, but has almost tripled in growth (290%) between 1998 and 2000.

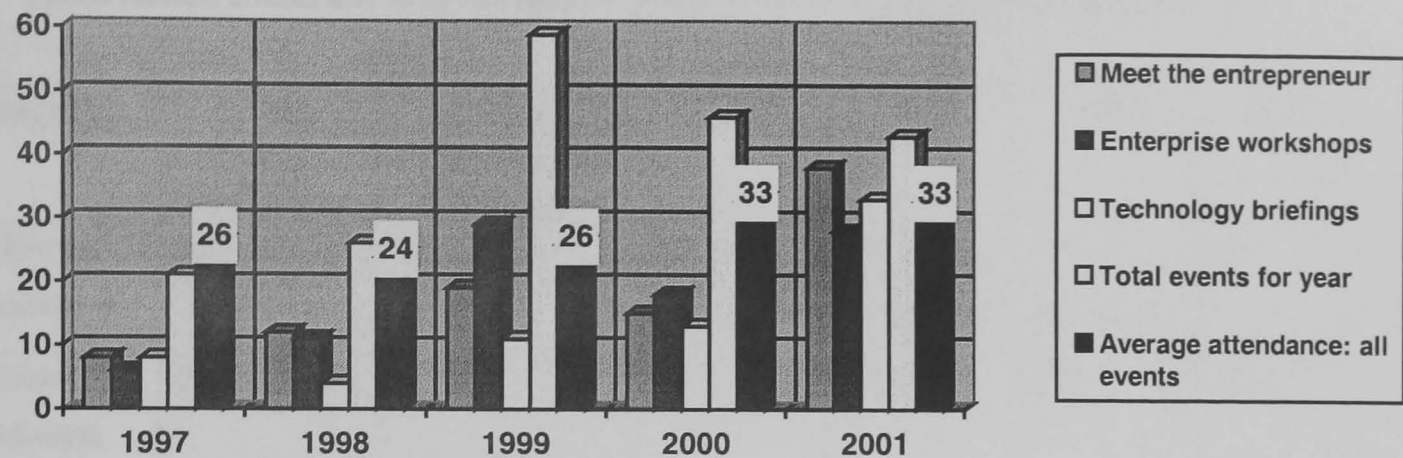
Graph 8.2: Total Attendance to Recurrent Events, 1997-2001



Graph 8.3 provides a more accurate picture of attendance patterns to Connect's core events for the 4-year period and help to put in perspective the apparent 'slow down in 2000' mentioned earlier. It shows that Connect ran a total of 46 core events in 2000 compared to 59 in 1999. Most revealing however is the average attendance to all events, which shows a consistent pattern of total average attendance to core events of about 26 for period 1997-1999 with a significant increase in 2000 to 33. This means that absolute attendance for year 2000 actually leaped forward by more than 25%.

It is interesting to note the role played by the event "enterprise workshop" since it is largely responsible for the 180% increase exhibited by the total number of core events between 1997 and 1999. Indeed, the number of 'enterprise workshops' increased steeply from 6 in 1997 to 29 in 1999. At the same time, average attendance to these workshops more than doubled from 21 in 1997 to 59 in 1999. In 2000, this attendance dropped to 46, still double the attendance average in 1997 and well inside the average attendance of 25 set by Connect's quantifiable targets. It can be concluded that Connect has achieved its quantifiable target of 'average attendance of 25 to core events' over the 4 years 1977-2000.

Graph 8.3: Number of Annual Events by Type, Total Events by Year, and Average Attendance to Total Events, 1997-2001



8.3.2.2 Stakeholder Mix and Number of Events

The ‘percentage of stakeholder’ targets were originally created by Connect Director Ian MacDonald to ensure that there was an effective mix of stakeholders at recurrent events. There is a difference between the target categories (business professionals, universities and technology companies) with the categories used for attendance at the real events (sponsors, universities, technology companies, individuals and others). For comparative purposes, the discussion that follows equates “business professionals” with “sponsors” and “technology companies” is also assumed to include “individuals” and “others”.

Table 8.3 below provides an overview of achieved number of events, and percentage participation by stakeholder against the quantitative targets originally set by Connect for their first 4 years.

**Table 8.3: 'Mix' of Network Stakeholders: Connect's 4-Year
Quantitative Event Targets and Achievements (1997-2000)**
(Total Annual Events and % of Attendees to Recurrent Events by Each Stakeholder Category)

Category	4-Year Target 1997-2000	4-Year Achievement 1997-2000	2000	1999	1998	1997
Total Events (Cumulative)	162	177	49 (177 cum)	68 (128 cum)	33 (60 cum)	27
% Business professionals	20%	23.5%	15%	23%	27%	29%
% Universities	30%	16.25%	20%	18%	15%	12%
% Technology Companies	50%	29.25%	30%	29%	27%	31%
% Individuals		5.25	9%	5%	4%	3%
% Others		25.75	26%	25%	27%	25%
% Companies, Indivs., Others		60.25%	65%	59%	58%	59%

The first point to note from the first row of Table 8.3 is that Connect has exceeded the targeted 'number of total events.' It has run 177 events against the target of 162 and the 177 events only account for core and investment events, without including meetings. The second row reveals that the percentage of sponsors (business professionals) shows a reverse trend, decreasing from a high of 29% in 1997 to 15% in 2000. The overall target of 20% however has been met.

The situation with universities (third row) is revealing of one of the major challenges still faced by Connect Scotland. Here, the original target for university attendance was 30% of the total attendance. The average result for the entire period 1997-2000 is just over half at 16.25%. The encouraging fact however is that it started with 12% in 1997 and has increased consistently to reach 20% in 2000.

An important observation from Table 8.3 (fourth row) is the stable percentage of technology companies (around 30%) over the 4 years of attendance to core events. The target was for a 50% attendance of technology companies. One explanation for this

variation is that companies are 'signed up' in two other categories, *individual members* and *others*. Together, these 3 categories comprise just over 60% of attendees to core events in 2000, well beyond the target of 50%.

What do these event and attendance patterns reveal regarding Connect's network-building objectives? All targets have been achieved except for the percentage of university participation at events (16% instead of 30%). Another observation is the progressive drop in sponsor attendance from 1997 to 2000. These findings will be further discussed in section 8.5.

Returning to Connect's original objectives for these events, as described in Table 8.1, results suggest that:

- ◆ The attendance objective of 'enterprise workshops' (to bring together technology companies and researchers with advisors and business professionals for the purpose of developing general management skills) is proving highly attractive to all stakeholders. Sponsors, companies and universities display the highest level of attendance.
- ◆ The attendance objective of 'meet the entrepreneur' is proving attractive to sponsors and companies, the primary intended target of the event. Universities and individuals attend the least, so this event has not developed into a platform for stimulating strong university-industry relations.
- ◆ The attendance objectives of 'technology briefings' are not being fulfilled at present given that attendance by sponsors and companies is quite low. The objective of technology briefings is to provide a forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies. The attendance patterns suggests that there is much to be done to stimulate closer relations and interactions between university and business. The challenge for this event is to find ways to increase the mix of attending stakeholders. On the positive side, this event has almost tripled in growth between 1998 and 2000.

8.3.2.3 Collaborative Projects, Spin-outs and Funding

Evaluation of Connects 4-year targets does not find direct evidence of collaborative projects, spin-outs, funding and employment being directly attributed or facilitated by Connect. This difficulty in verifying these targets using available information has provided justification for the methodological approaches used in this thesis, including survey evaluation of stakeholders described in section 8.4 and case evaluation results described in Chapter Nine.

8.3.3 Operational Challenges to Growth

Connect's growth from pilot project to national program in 1998 has resulted in significant network growth but created new operational challenges. One challenge is to create an awareness of a national network rather than simply Edinburgh-focused. Connect CEO Ian MacDonald concedes that the Edinburgh University brand was essential in gaining credibility for Connect. As identified earlier, the support of the Edinburgh University Principal was instrumental in the programme having a home and access to an administrative support system.

All of Connect's directors, (Andrew McNair, Susan Morrison and Gillian Mayman) have commented that a considerable amount of their time and energy has been taken up in dispelling this perception of Connect as a program favouring specific regional or institutional interests.

Another operational challenge is increasing constraints to autonomy in remaining a university-based program. CEO MacDonald points out that although Connect's strategic and operation activities have been lead by an external advisory board since 1996, processes and procedures related to staff, finance, personnel and administration are aligned with those of the university. This has limited decisions on staff salaries by Connect as they are set on a university pay scale.

Advantages of Connect as an independent company from Edinburgh University, according to Ian MacDonald, include single line reporting that is not encumbered by rules and regulations of a large university and spending less time dealing with bureaucracy issues and more time see companies and sponsors.

Connect identifies the need for a professional board of directors that is not possible as a university program. Although founding sponsors provided the initial governance of Connect, a national board was established once Connect became a Scottish-wide program and sponsors became members of the advisory board instead. According to Gillian Mayman, the national board has been highly useful as a strategic catalyst and providing advice to Connect and its ongoing development. However, the problem with the advisory board, Gillian says, is that all 63 sponsors are members, creating in essence a shareholder group. At the same time, there is an ongoing flux in sponsor attendance to Connect events, with the challenge being one of keeping all sponsors informed of Connect activities, not only those actively involved on the advisory board.

A professional board would allow all sponsors to resume participation on an equal basis so that Connect is perceived as an inclusive rather than exclusive network, and to avoid those sponsors with deeper pockets to dominate the Connect agenda. Indeed, the initial aim for Connect was to be majority private sector funded.

8.3.4 Preparations for Spin-out: Connect's Evolution to an Independent Company (to June 2001¹⁰)

Connect and its advisory board made the decision to pursue a new direction as a private company and leave the university, beginning negotiations with Edinburgh University in 2000. Although negotiations were not as smooth as Connect had hoped, the University agreed to an official date of June 1, 2001 whereby Connect would cease to be a university-based program. One concession granted Connect was that it could remain in the Management School until a suitable new premise was secured.

¹⁰ Interviews were completed in April-May 2001 as Connect was poised to begin operations in June as a private company.

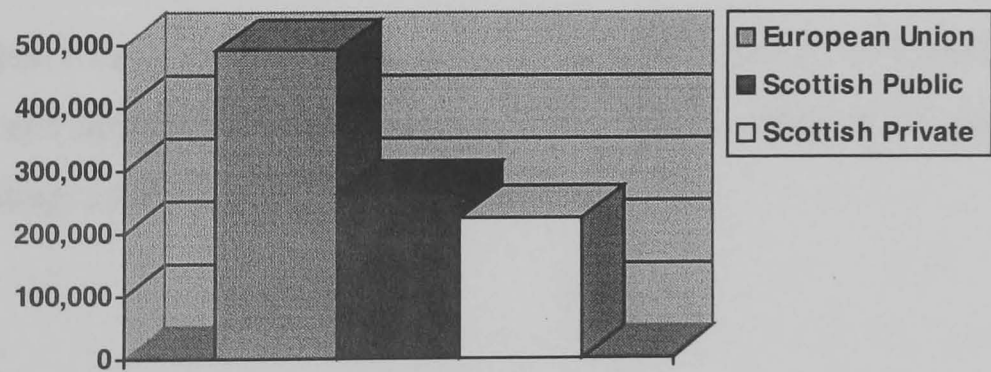
Described below, Connect directors and stakeholders identify potential challenges facing Connect just prior to its transformation into a private company in June 2001.

8.3.4.1 Financial Self-sufficiency

Financial self-sufficiency is seen as the most pressing concern facing Connect as a private entity, as it will no longer be eligible for ERDF funding and will have to cover finance and administration activities previously provided by the university.

From 1997 to 2000, Connect had raised close to £1 million in private and public sources, amounting to an approximate average cost of £330K per year to finance its operations. Graph 8.4 shows that Scottish public sources, including universities, have contributed approximately £270K to Connect (about £90K per year). Without counting the funds from university sponsorship (£118K), this amounts to close to £150K total or £50K per year.

Graph 8.4: Public and Private Sources of Funding for Connect (1997-2000)



This money has in turn leveraged over £220K from private sector sponsors and close to £500K from European Union funding for Scotland. To June 2001, funding has not been a resource constraint for Connect operations. CEO Ian MacDonald states that there has always been enough funding to allow Connect to deliver what it desired up-front.

Gillian Mayman identifies that public funds have provided Connect with a significant advantage in growing its network. She states that Connect has been able to exercise flexibility and latitude in using the funds to develop its events and activities without restrictions from preconceived guidelines tied to funding. Thus the public funds have not hindered the progress of Connect or its ability to develop innovative programs.

From this point of view of value for Scottish public money, it could be argued that Connect represents a rather inexpensive program, given Connect's development of a multi-stakeholder national network and in comparison to the costs involved in operating local enterprise companies (LECs) or other support programs provided by Scottish Enterprise, such as the Scottish Birth Rate Strategy.

At the same time, evaluation of Connect's initial quantifiable targets (1997-2000) created by CEO Ian MacDonald suggest that the challenge remains for Connect to raise network value to the more demanding targets it sets for itself. As described, measuring attribution to Connect of some targets is not easy to ascertain with available information and has prompted further investigation underpinning much of the research efforts undertaken for this thesis.

According to Ian, these original performance targets for Connect will need to evolve into more realistic and applicable targets based on the specific needs of its membership with Connect becoming a private company.

8.3.4.2 Re-valuing Services

Program Director Gillian Mayman argues that Connect will no longer be able to give services away as it has done in the past. To date, Connect's philosophy for attracting new members and sponsors has been to invite people along to events without them having to commit. Gillian states that often these people will continue to attend Connect events without committing, and that this may have to change as Connect seeks a financial return in exchange for the value they provide as a private company.

Reliance on membership revenue is expected to change the approach taken by Connect in managing its network. Gillian asserts that the greater need for revenue and cost assessment will require a more formal approach to membership and enrolment. Events are expensive to run, and one approach may be a staggered membership depending on the number of employees in the company that will use the Connect network. Another suggestion by Gillian is to charge those people who sign up but don't show up to events, particularly because drop-out rates to some Connect events have been high.

8.3.4.3 Evolving Sponsor Expectations

Connect as an independent company will need to provide greater accountability to sponsors according to Connect Director Andrew McNair. Up to 2001, Andrew suggest that sponsors have not measured their return from their sponsor fees with the amount of new business generated through Connect. As Ian MacDonald made clear back in 1997: *"... From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years."* With Connect now in its fifth year of operations, Andrew suggests that sponsors will be more discerning regarding the expectations.

Gordon McAndrew, Chairman of WL Ventures and former Board Member of Connect, states that Connect sponsors require a better flow of start up companies in the technology sector with a higher likelihood of success to produce a better economic environment within the region (in this case West Lothian). Personally, Grodon expects that through Connect's efforts, WL Ventures may find people in whom it can invest. Gordon acknowledges that Connect's provision of advice and training to a new company presenting at the 2001 Springboard in Glasgow made it easier for WL Ventures to deal with the new company on issues of finance, strategy and future prospects.

For the future, Gordon asserts that Connect needs to continue the present programme of events that include local events and the national conferences such as springboard and the investment conference. One thing Gordon would like to see is more attention directed at

technology spin-outs that arise from existing industrial companies. Just as the university person has limitations, so has the R&D manager of an existing company, and Gordon feels that expanding support to industrial spin-outs would be complementary to Connect's mandate for supporting technology companies in Scotland.

8.3.4.4 Greater Value to Technology Company Members

Connect also needs to meet the evolving requirements of technology-based companies according to Ian and Gillian, who agree that Connect must provide a sharper focus on specific needs of companies at their various stages of commercialisation and development. At the same time, Connect must ensure that their activities are not overlapping with those services already offered in the marketplace, often by Connect sponsors.

Connect has been highly focused in its early years on start-up technology companies, and one of the three core events, enterprise workshops, continues to emphasise topics related to entrepreneurs and the development of new companies. According to Gillian, Connect provides the greatest value to the *start-up* technology company, therefore the majority of Connect events focus on topics and issues most relevant to the early stage technology company.

As new companies develop and grow, it is more difficult to determine where value can be added as a support mechanism, Gillian states. In Connect advisory and staff meetings, the spread of events over the course of the year is assessed with the objective of providing value to both early stage and developing companies. The dynamics of Connect's member companies are assessed, and feedback from these companies regarding their needs is considered in establishing new event topics.

Connect North Director Susan Morrison concurs with her Connect colleagues and asserts that Connect requires greater emphasis on a customer-focused approach. This includes delivering on time and meeting deadlines, greater involvement from the Connect Board

and Chairman, delivering more tangible benefits to sponsors and ensuring that events are valuable to companies.

Connect aspires to position itself in Scotland as the benchmark and first stop for any technology company at any stage, according to Andrew McNair. Connect also intends to be the contact network not just for zero stage or first round stage investment but later stage. The vision is to capture the knowledge and experiences of creation, development and commercialisation activities within the Connect network and to keep that cycle ongoing. This allows retention and development of the entrepreneurial drive that creates and forms a small company to spin out and back round to the Connect network, similar to the model used successfully by Connect San Diego.

Connect's continual evolution may see it become an investment management company, using its extensive network of private sponsors to raise funds and leverage a recognisable brand. However, Gordon McAndrew argues that Connect should not evolve into the provision of capital to technology companies. Gordon suggests that issues such as conflict of interest with sponsors, the need to acquire an entire set of professional skills and the time and energy by Connect to seek out and establish an investment fund are reasons for Connect not to get involved. Connect should continue to act as a catalyst by knowing where the sources of money are and providing people with information.

8.3.4.5 Improving Relations with Complementary Initiatives

A further challenge for Connect is working with other people in the support environment in Scotland. Connect is not self contained and *'needs to be giving and taking in all directions, and encouraging give and take with the various agencies who are trying to do the same or similar sorts of things'*, according to Gordon McAndrew.

At the same time, Connect's credibility as a successful regional support program model has been substantiated in 2001 when the program, its brand and logo were copied with permission from Connect Scotland by the Midlands region (University of Warwick) and by

Yorkshire in 2001. Both these English-based programs are using Connect Scotland expertise to assist in start-up.

8.3.5 Section Summary

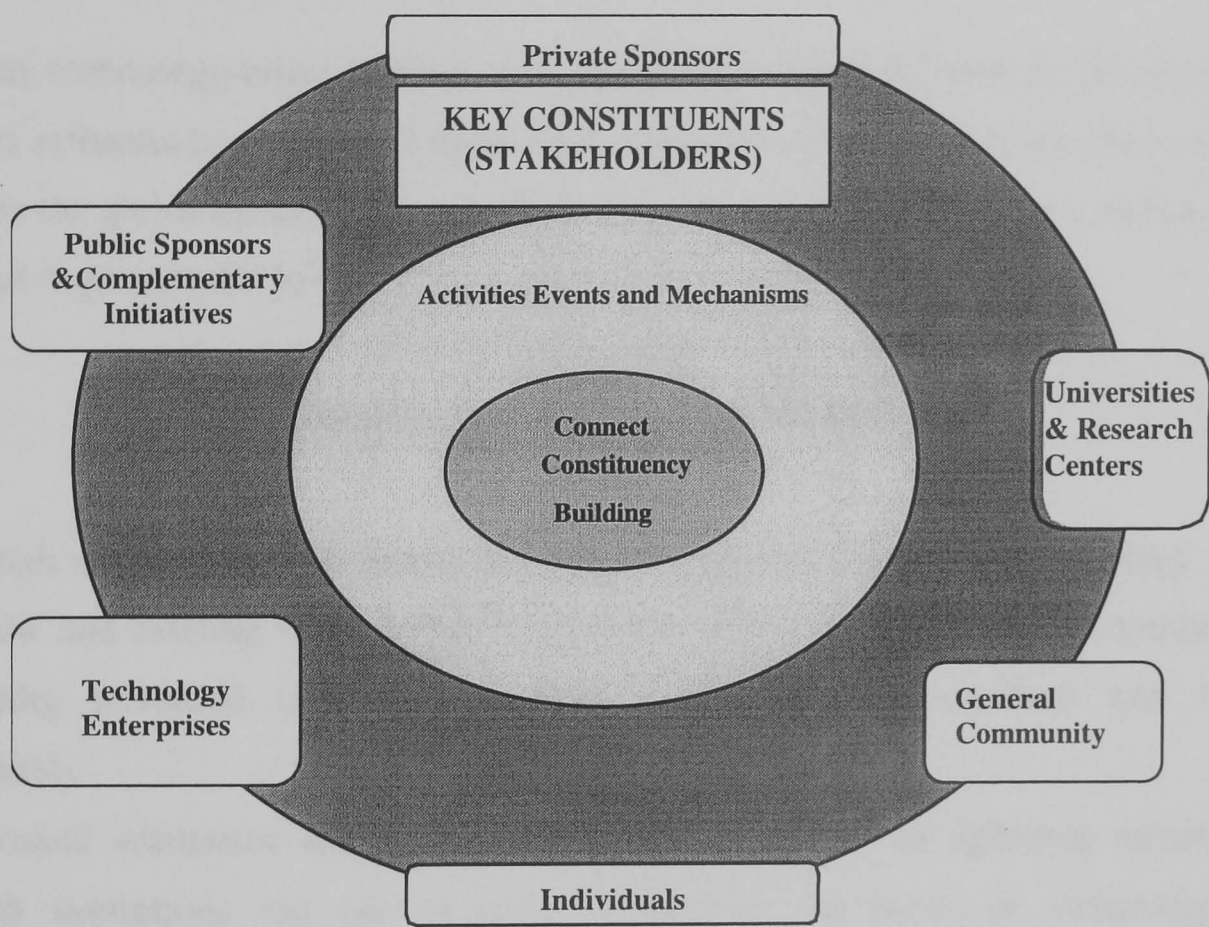
Key findings in the early formation and development of Connect's national network include: strong evidence of need for intervention and support, establishing early private-sector program credibility by involving a high profile business leader and early public sector program credibility with support from Scottish Enterprise and Scotland's leading research universities. The identification of clear benefits to be derived by stakeholders of the network and a formal, integrated set of events and activities bringing together stakeholders is based on a proven and successful US model.

The constituency-building model used to examine Connect Scotland in this section emphasises the interrelations between: Connect as a formal network 'manager'; the events, activities and mechanisms it uses to realise its objectives; and the specific stakeholders and their expected benefits. The next section will examine results of the stakeholder analysis to establish the level of benefits being realised by stakeholders.

8.4 NETWORK STAKEHOLDERS

Connect’s events, activities and mechanisms focus on key stakeholders involved in technology-based entrepreneurship (Figure 8.4). They include technology companies, universities and research institutions, private service providers, public complementary initiatives (support agencies) and the more general community.

Figure 8.4: Key Constituents or Stakeholders of Connect Scotland



Connect has identified specific benefits for each of the key stakeholder categories seen in Figure 8.4 that are described below:

Technology Enterprises¹¹

Technology companies will benefit from an enhancement in their ability to:

- ♦ access new markets, clients, partners, products, technology and finance, and improve marketing skills; access to technical and managerial assistance;

- ◆ secure developmental/growth funding;
- ◆ stimulate collaborative projects between technology businesses and universities/research centres, including access to national and international sources of R&D funding and capitalisation;
- ◆ facilitate and enable the creation of spin-out companies from the Scottish science base and established technology companies;
- ◆ learn about business development and issues germane to their industries; and receive help to define new businesses and whether they should start them.

In general, technology-based ventures and companies will benefit from the development of an expert infrastructure that understands and supports, and benefits from, their needs for success in the global market. The overall result is envisaged to lead to the creation of new, additional 'high income' jobs.

Universities¹² and Research Institutions

- ◆ Scottish science base will benefit from facilitation and support for technology transfer to new and existing firms, either by spin-out or through collaborative projects; this includes increased interaction between campus-based researchers and industry scientists.
- ◆ Individual academics and researchers will benefit from an effective infrastructure which institutions can use to better understand the needs of technology-based companies and financial sectors and to commercialise their research;

Service Providers (e.g., regional attorneys, bankers, accountants and marketing professionals)

- ◆ Service providers will benefit from enhanced competence regarding high technology products, companies and industries. This happens through the provision of technical

¹¹ These are defined by Connect as companies competing on the basis of proprietary technology or know how.

¹² The Connect San Diego model deals with one university, the University of California, San Diego (USCD) and remains a university-based program. On the other hand, Connect Scotland deals with 14 universities and will no longer be a university-based program as of June 2001.

briefings and education about unique characteristics of high-technology products, financing, manufacturing and marketing.

‘Complementary Initiatives’ and General Community

- ◆ Complementary initiatives (support agencies and programs) will benefit from the provision of a resource that can be used by all participants.
- ◆ The general community is expected to benefit from increased community awareness of the issues affecting the development of high technology enterprises, as well as from the provision of a community resource for data and information on the status of research activities and business development in the high-technology sectors;

All the above parties are envisaged to profit from the access to a common network of expertise, resources, and the opportunity to interact on a regular and informal basis through the Connect program described in the next section.

8.4.1 Participation Growth and Retention Analysis - 1997-2002

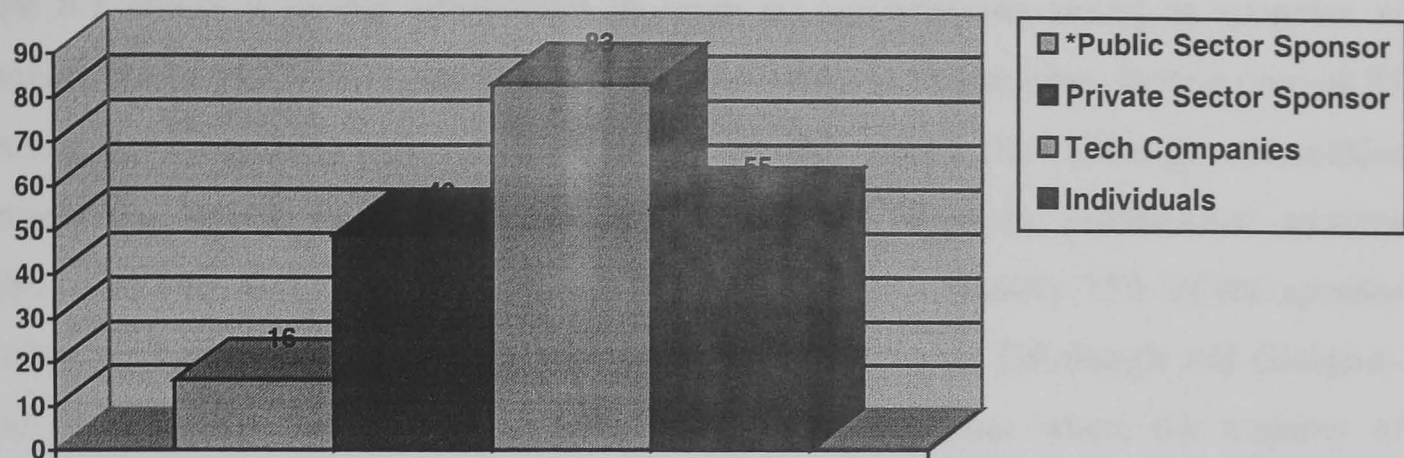
This section examines stakeholder membership growth and retention data to qualify earlier assumptions regarding Connect’s growth and identify factors affecting why stakeholders enter and exit the network.

Overall, the size of the Connect ‘subscriber’ constituency has grown significantly over 6 years (1997-2002) to 148 organisations (65 sponsors and 83 member companies) and 55 individual members. Connect ‘subscriber’ constituency¹³ follows the Connect Office’s data categorisation of sponsors, universities, companies and *individuals*. Graph 8.5 shows the number of paying stakeholders associated to Connect by category at June 2002.

¹³ Subscribers are those organisations or individuals paying a membership fee to join Connect.

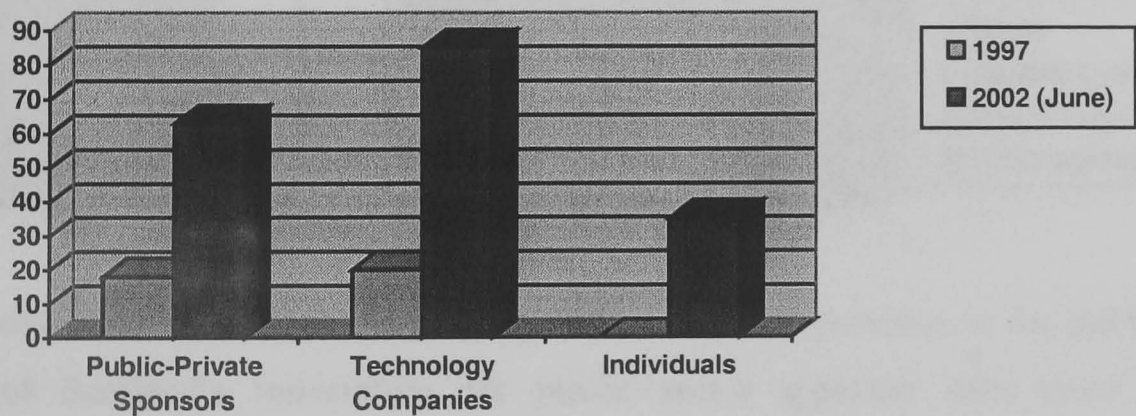
Graph 8.5: Stakeholder Categories of Connect (to June 2002)

(*public sector includes all 14 Scottish universities, Scottish Enterprise and SHEFC-Scottish Higher Education Funding Council)



Graph 8.6 shows this growth for sponsors, companies and individuals, with universities included in the sponsor category. All categories, in particular companies, show substantial growth. It should be emphasised that all 14 Scottish universities are sponsors of Connect.

Graph 8.6: Stakeholder Membership Growth (1997-2002)



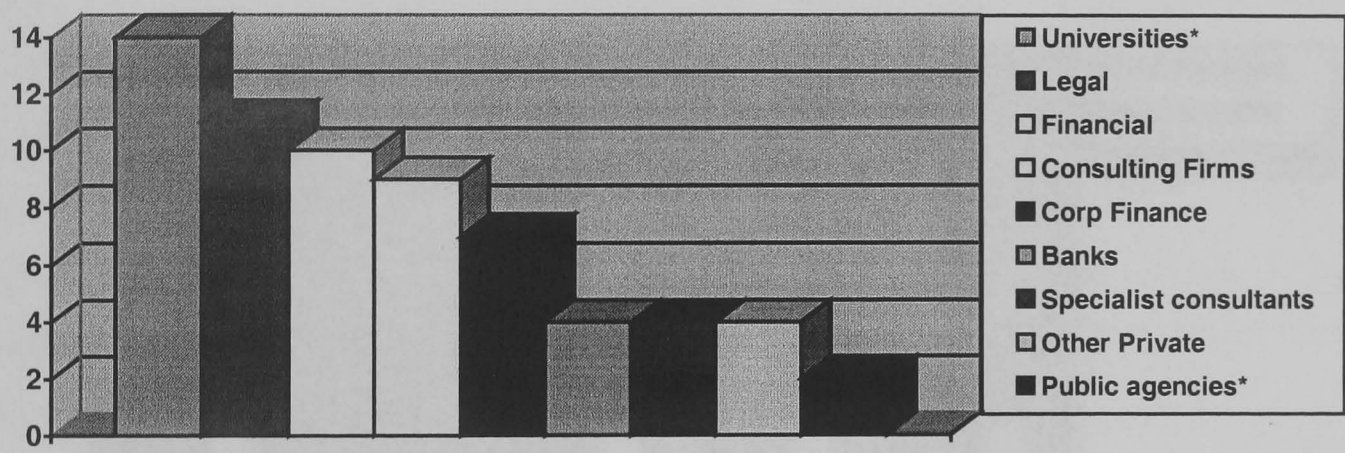
Although overall growth in ‘subscriber’ stakeholders seen in Graph 8.6 suggests that Connect is delivering value to each stakeholder category, this cannot be assumed without further information. Determining how stakeholders perceive the value of Connect will be substantiated by results from the surveys and cases in chapter nine.

The next section will qualify stakeholder growth shown in Graph 8.6 by examining membership retention rates and factors affecting the level of network entry and exit by sponsors and technology companies.

8.4.1.1 Sponsors

Graph 8.7 shows a further breakdown of types of organisations acting as sponsors of Connect. Since 1997, there has been a three-fold increase in sponsors, from a core of 21 founding sponsors to 65 in June 2002. Graph 8.7 shows that although universities represent the largest single ‘homogenous’ category of sponsors, professional services (legal, consulting and investment agencies) comprise approximately 75% of the sponsor membership base. As expected, private sponsors are primarily Edinburgh and Glasgow-based or along the central Scottish belt between the two cities where the majority of Scottish businesses are located.

Graph 8.7: Private and Public* Sponsors of Connect Network (n=65)



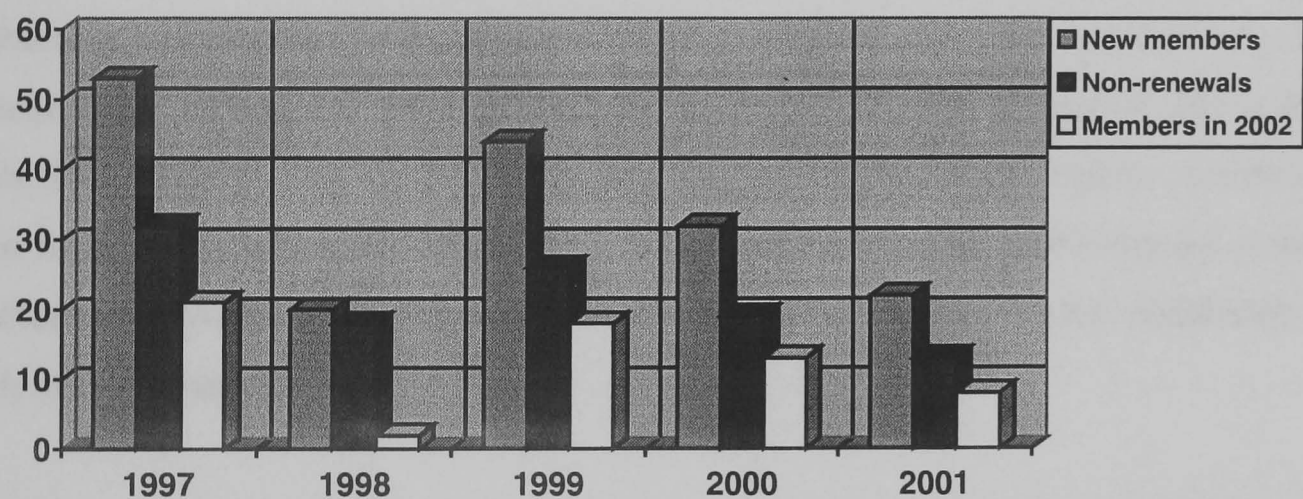
The regional element of Connect is more evident with the presence of the public sponsors. All 14 of Scotland’s universities are public sector sponsors with these universities representing a broader spread geographically. Scottish Enterprise (SE) is Connect’s major single public agency sponsor, and as Scotland’s leading economic support agency, provides local enterprise companies (LECs) throughout Scotland that deliver general business support. SE’s early and continual support of Connect is based on Connect’s national mandate and its focus on Scottish technology sectors.

Overall, annual membership renewal by private and public sponsors continues to remain high with over 90% of private sponsors and 100% of public sponsors renewing membership in 2001.

8.4.1.2 Members

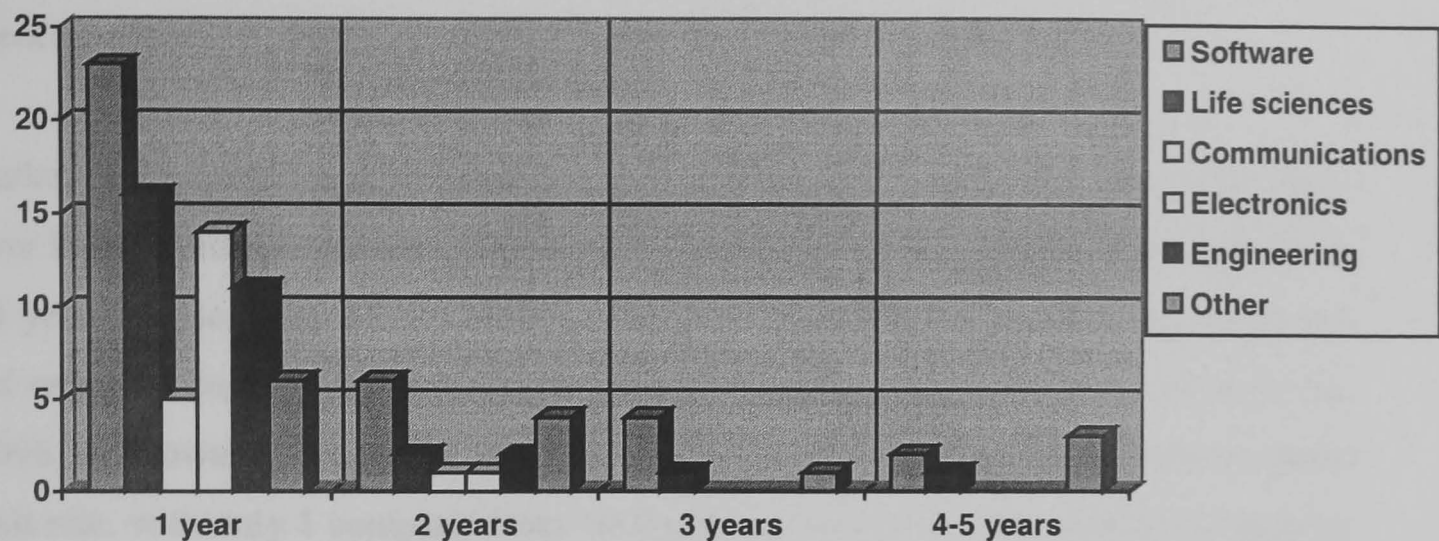
Examining company retention patterns shows a very different picture to that of sponsors. Although Graph 8.6 shows a five-fold increase in members of Connect since 1997, the total number of company members fell between 2001 and 2002 from 106 to 83. Graph 8.8 shows member retention using data on annual new members, non-renewals and continuing members since 1997. Similar ratios are evident for 1997, 1999 and 2000 between new signs-ups and non-renewals that result in a retention rate of approximately 40% for each of these three years.

Graph 8.8: Network Retention of Companies: Number of Annual Technology Company Sign-ups, Non-renewals and those remaining as Members in 2002



Market conditions, as expected, play a significant role in explaining retention patterns of company members. Graph 8.9 shows retention of technology companies by sector reflecting the high turn-over pattern for all technology sectors after year one. Companies retaining membership for over 3 years reflect a balance between electronics and software companies, and an almost equal number from other sectors, including 2 biotech and 2 telecom companies. The higher retention rate of the 'other' category reflects a mix of sectors such as incubators and industrial application.

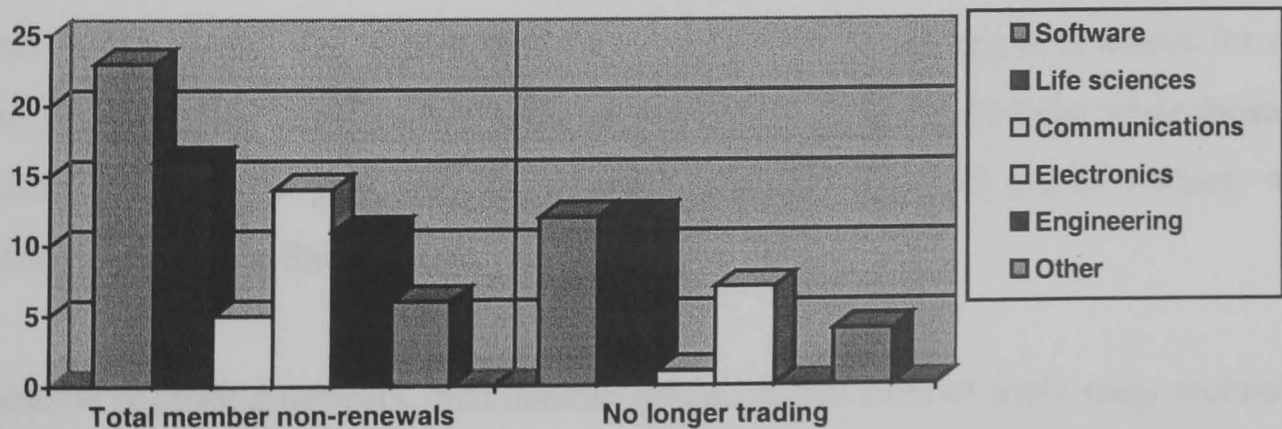
Graph 8.9: Network Retention by Sector: Number of Companies and Length of Time as Members of Connect Network (1997-2001)



Graph 8.9 shows the pattern of retention according to technology sector, showing that although software companies are the dominant sector retaining long-term network membership, electronics companies show the highest rate of retention in 1997. Biotechnology companies were highest in 1999. This view suggests that network membership patterns will vary year by year because Connect’s company members are drawn from across a breadth of sectors. At the same time, this multi-sectoral company constituency provides some level of network stability, because market conditions vary widely between sectors.

A significant factor explaining almost half of the total non-renewing memberships since Connect commenced operations is companies ceasing to trade (Graph 8.10).

Graph 8.10: Non-renewing Company Members of Connect versus Companies Ceasing to Trade (1997-June 2002)



Graph 10 shows that 36 companies (out of 75 non-renewing memberships) have ceased trading as of June 2002, with the majority of these companies (67%) from the software and life sciences sectors.

But market and sectoral conditions do not fully explain the significant level of company turn-over in the Connect network. Connect CEO Ian MacDonald concedes that Connect in its first years of operation did not actively focus on securing company memberships and focused rather on building the national network and establishing a pattern of events. The year 1998, as shown in Graph 8.8, demonstrates both a low level of new members and a high exit rate, with only 1 company from 1998 still remaining as a member of Connect in 2002. Ian and two of Connect's directors attribute the low level of retention in 1998 to the fact that all efforts were focused on developing Connect from an Edinburgh-based project into a national network. Ian also concedes that part of the retention problem has been a lack of marketing Connect to companies. Much of Ian's time in the past has been devoted to attracting sponsors into the network and securing sponsorship investment.

Another explanation given by Connect is that engagement in the network by entrepreneurs and technology companies continues to be non-mandatory and flexible. However, this argument is valid for sponsors, and retention remains high in that membership category.

Indeed, based on the retention rates identified above, the Connect CEO was asked about the high turn-over of technology companies as it affects expectations by private sector sponsors to secure new companies as clients. Ian suggests that the high level of attendance to Connect events (Graph 8.2) provides a satisfactory 'high churn' for sponsors to identify high potential clients while acknowledging that most new companies will not have resources to hire them. Ian argues that those companies remaining in Connect for more than one year are more likely to hire professional services as they develop while those that leave Connect after one year may or may not, depending on the initial contacts made during their time within the network.

One question regarding network membership related to the level of early-stage technology companies (less than 5 years old) that are members of Connect among the total 'pool' of

technology companies in Scotland. This figure was not available from Scottish Enterprise or any other public agency, indicating a problem regarding measures of emerging enterprise formation among total new venture creation figures using VAT data.

An estimate by Connect suggests that the actual population of technology companies in Scotland is approximately 500. Approximately 75 of those in any one year seeking to raise investment finance and approximately 50 (10%) will cease to trade that include companies being acquired and companies failing. This population of 500 will turn over again over a 10-year period according to Ian. Ian thus forwards the argument that the actual population of companies that are appropriate for Connect is quite small, drawing from an estimated population of 150 companies from the estimated 500 in Scotland that will be less than three years old¹⁴.

Membership retention results described here have been acknowledged by Connect as a key challenge to its future plans to become a private company. Chapter Eleven will further examine how Connect has met this challenge through its new business model by evaluating Connect one-year after it became a private company.

¹⁴ "Technology companies" are defined by Connect as those competing on the basis of proprietary technology or know how.

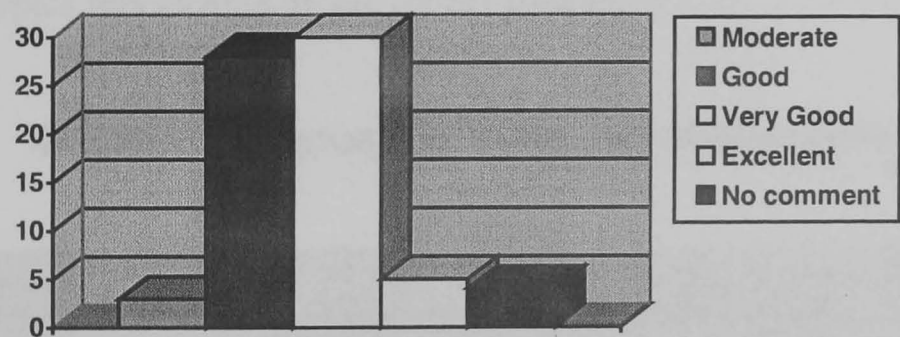
8.4.2 Stakeholder Perceptions of Network Value (1999)

This section examines network benefits and value, based on perceptions from a total of 116 Connect stakeholders (67 in 1999 and 49 in 2001) who provide feedback on 3 areas of inquiry: 1) quality of Connect events and mechanisms; 2) perception of social, knowledge and financial value flows; and 3) recommendations for improvements and general comments on Connect value as a support network. Results are described according to stakeholder group - sponsors, universities, technology companies and individuals/others – beginning with the 1999 survey.

8.4.2.1 Event Quality

Graph 8.11 shows that Connect events were rated ‘good to very good’ by 58 of the 67 respondents (86%), exceeding Connect’s 4-year quantifiable target objective: “75% of participants rate event as ‘good’ or better, according to perceived value”.

Graph 8.11: Quality of Connect Events (n=67)



Comments on quality of recurrent events revealed three common themes:

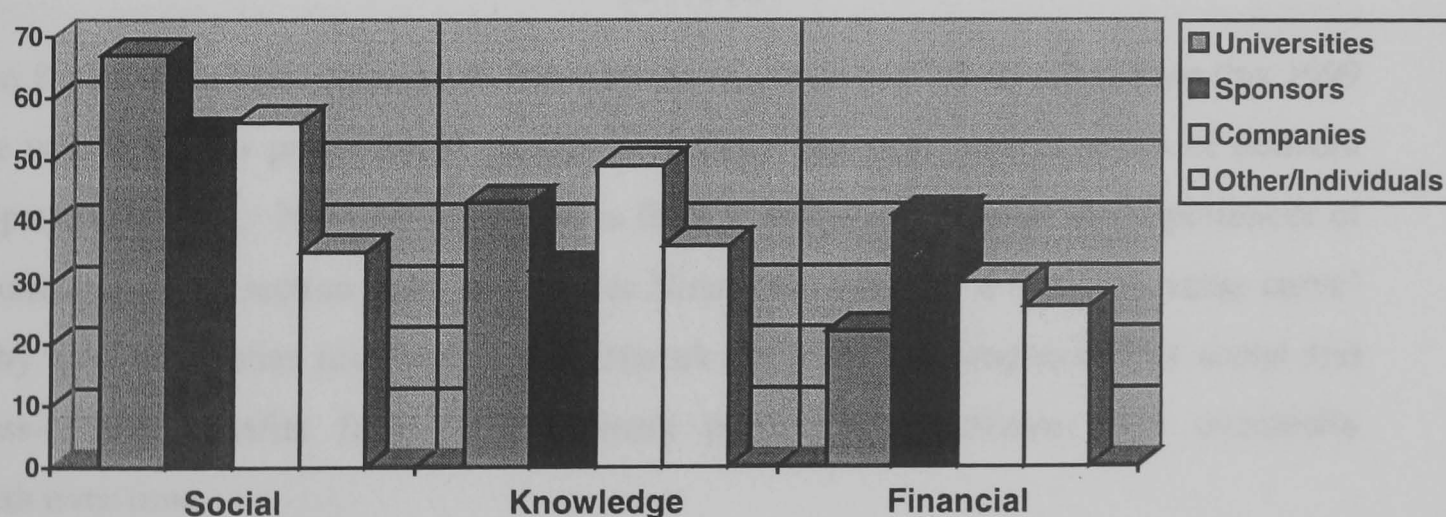
- Events are well organised and well timed (majority of comments);
- Events are relevant across a range of interest areas, providing both immediate relevance and background interest (majority of comments on content);
- Connect has, to date, been able to attract and sustain a high quality group of speakers. Quality of speakers is an important feature of attracting people to events, particularly with the increase in the number of network programs and sector-specific associations (majority of comments);

- More international speakers as Connect has utilised many of Scotland’s existing business ‘names’ in previous events and Connect competes with other events that also have high quality speakers (6 comments);
- Connect moderator needs to take a more active role, and “*provide more impact if the speaker is not dynamic*” (3 comments);
- Logistical difficulties to attend events from those distant from Glasgow, Edinburgh or Aberdeen (for instance, of a total of 20 Enterprise Workshops during 1999 – 8 took place in Edinburgh, 5 in Glasgow, 6 in Aberdeen and 1 in Dundee) (3 comments).

8.4.2.2 Network Value Flows

Graph 8.12 shows comparisons of social, knowledge and financial value between stakeholder categories¹⁵. Social value is rated highest followed by knowledge and financial value respectively with one noticeable exception being ‘sponsors’ who rate financial value higher than knowledge value. A lower knowledge value by sponsors is suggested with the premise that many sponsors are knowledge specialists themselves and familiar with the commercial topics represented by the survey indicators.

Graph 8.12: Perceived Value (%) of Connect (n=67)

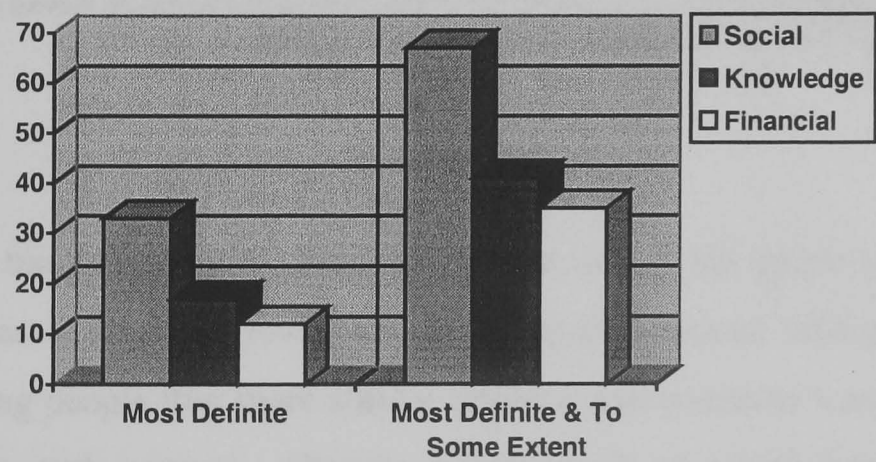


¹⁵ ‘Universities’ as a stakeholder category include only technology transfer office and related administrative personnel, rather than university scientists and those involved in ‘spin-out’ activity. This latter group is included in the ‘company’ category.

The high rating of social value seen in Graph 8.12 would be consistent with the evolution of networks where social interactions and acquaintances tend to precede the exchanges and collaborations involving knowledge and financial value (Falemo 1989; Butler and Hanson 1991; Larson and Starr 1993).

Graph 8.13 identifies the difference between affirmative responses to perceptions of social, knowledge and financial value overall. Following the assumptions of evolutionary network theory noted above, it is postulated that affirmative responses to knowledge and financial value will increase in relation to social value in the future. Indeed, an identified challenge for Connect in the future will be to “*increase the knowledge and financial value delivered by the network as perceived by its stakeholders*”. This statement is made because Connect itself explicitly states that knowledge and financial benefits, in addition to social value, are to be derived by stakeholders from involvement with the network.

Graph 8.13: Level of Perceived Value¹⁶ (%) of Connect Events (n=67)



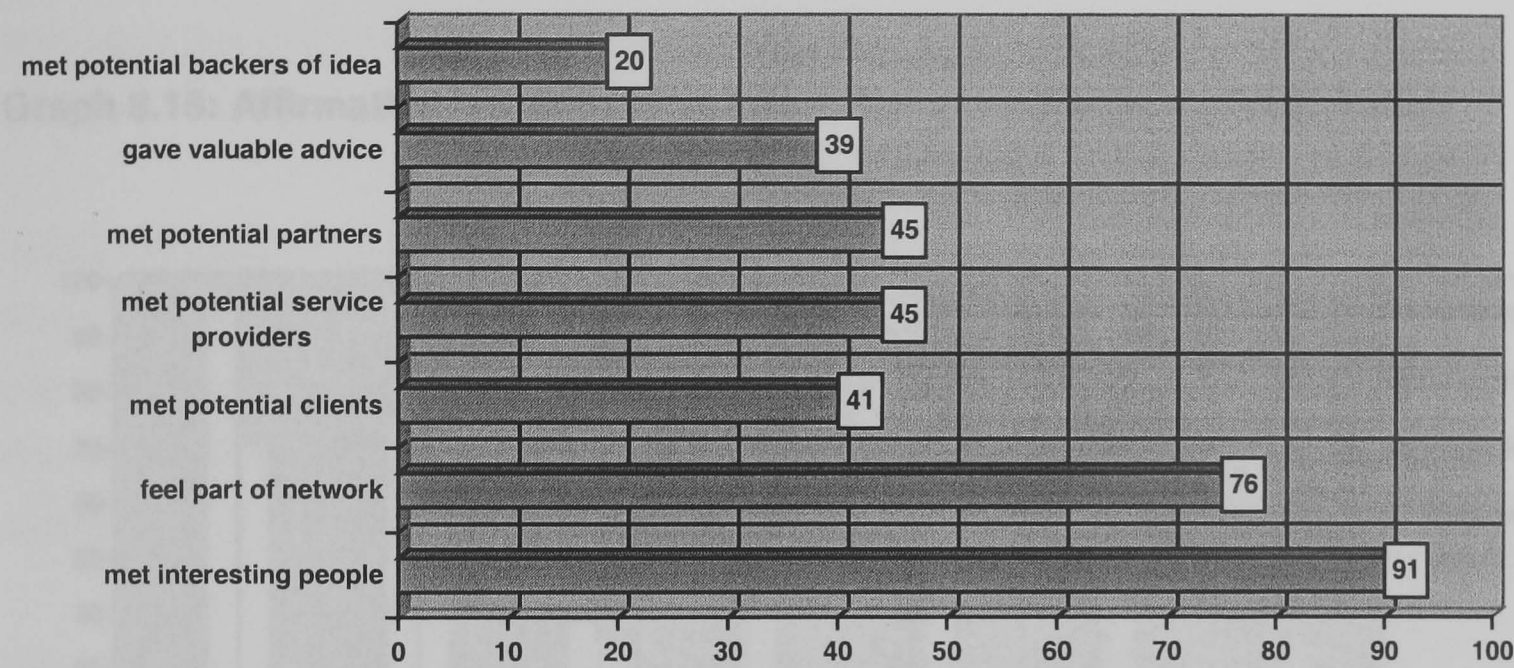
Section 8.4.3.2 examines changes to these levels of perceived value, comparing this 1999 sample with a similar proportional sample of stakeholders with similar levels of network participation in 2001. Network evolution is further examined through the experiences of case companies (see section 9.4.1 of Chapter Nine) that suggests a ‘network value curve’ whereby new companies involved in the network experience a progression of social and business-related benefits from their network participation activities that eventually diminish over time.

¹⁶ SPSS cross-tabulation: percentage of ‘most definite’ and ‘realised to some extent’ responses to total responses for each set of value dimension (social, knowledge, financial) questions.

8.4.2.2.1 Social Value

A better picture of social value emerges when responses to each social value indicator are compared as shown in Graph 8.14.

Graph 8.14: Affirmative Responses to Social Value Indicators (n=67)



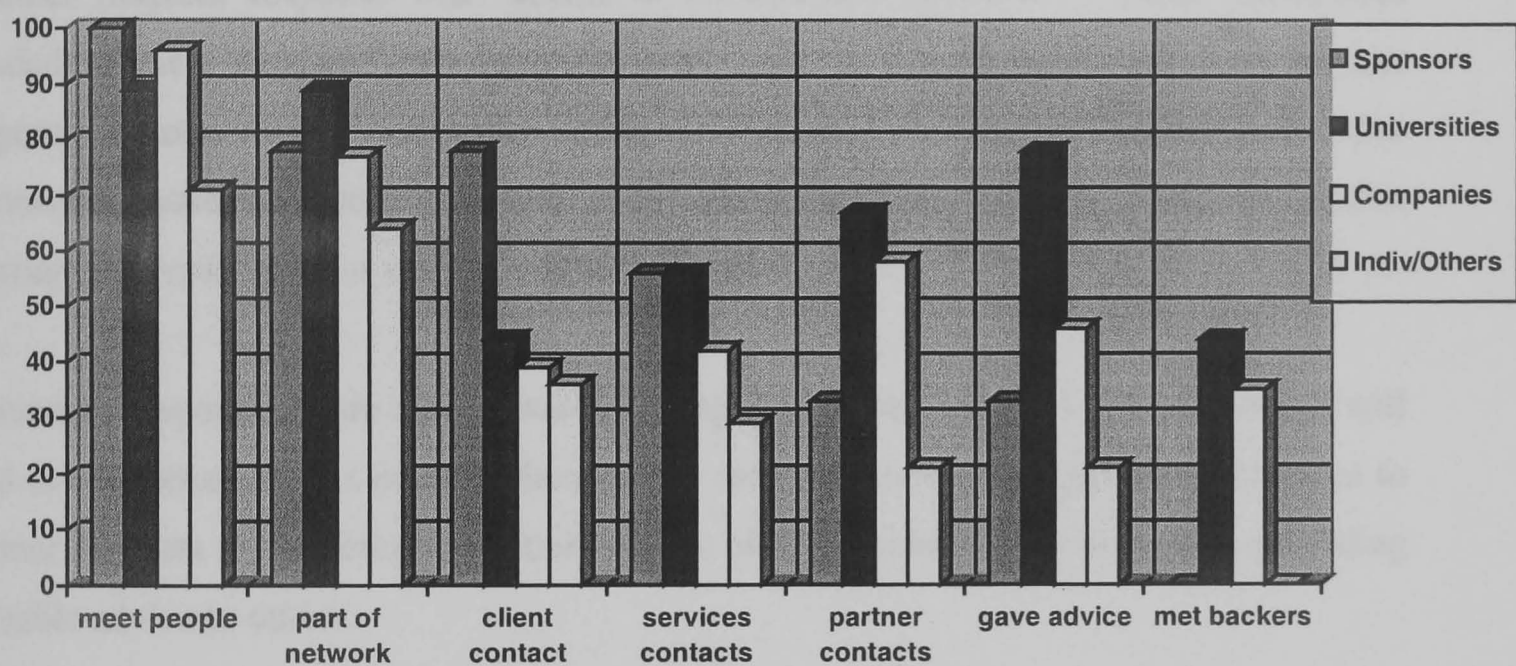
As expected, the more demanding indicators at the top of the graph (e.g. ‘met potential backers of my ideas’) are rated lower than more general ‘social affiliation’ indicators of ‘meeting interesting people that share similar interests and concerns’, and ‘feeling part of a network of advice and contact’. Clearly, a high level of social interaction within the network is suggested with a 91% affirmative response rate.

Looking more specifically at stakeholder responses by category, Graph 8.15 shows where stakeholders differ in perceptions, with these differences most evident in questions related to *social exchange*. Clearly, sponsors rate “client contacts” highest, while companies and universities rate “partner contacts” highest, reflecting different objectives for relationship building within the network.

Graph 8.15 shows a high rating given by university respondents to “gave valuable advice” while sponsor ratings to this indicator are significantly lower. A number of possible

explanations are forwarded here, one being that universities are public sponsors and are attributing advice provision in general terms and to those with university technologies active at Connect events¹⁷. The low level by sponsors, most of them private service providers, could reflect a greater selectivity on advice provision to only those considered to be potential clients of their services as private sponsors are used to charging for advice. As these suggestions are speculative, further findings will qualify these assumptions and be discussed later in the chapter.

Graph 8.15: Affirmative Responses to Social Value Indicators by Stakeholder Group (n=67)



Feedback from stakeholders provides qualification of survey results for each value dimensions.

Sponsor Comments

Sponsors generally describe Connect as an inexpensive network that creates good dialogue for support because “the key and important people are at these events” and “participants have the opportunity to draw on others’ experiences”. Two sponsors indicated that the quality of discussion at events is open and optimistic. A respondent representing a Scottish Enterprise LECs (local enterprise company) finds that Connect provides value as a forum

¹⁷ Twenty-one companies out of a total of 51 responding to the 1999 and 2001 surveys were identified as university spin-outs or start-ups.

for marketing its Science Park in Aberdeen to technology companies in attendance at events.

University Comments

University respondents generally identify Connect as an informal network for meeting key supporters of high technology in Scotland. One respondent states that “*networking is the start of everything, that includes the build-up of friendship and trust*”, echoing the importance that university stakeholders place on forming new social relations within the network.

Another frequent response was “*access to an informed network*”. Three universities alluded to their need to keep in touch with what is happening in Scotland; as one respondent states: “*[our] university needs to be there*”. Another respondent added that Connect is a valuable resource, in that “*[one] knows Connect is there if you need it, as it is a group of people within a supportive environment*”.

University respondents are unanimous in stating their expectation that social contacts will lead to collaboration. As noted earlier, survey results identify the high value attributed to partner contacts and meeting potential backers of their technologies as well as providing valuable advice to others.

Company Comments

Company respondents are more diverse than sponsors and universities in perceptions of social value. One common theme is the importance of Connect as a venue for initiating and developing social relations. As one respondent states: “*Networking is most important for first-time attendees to build relationships and for keeping in touch and keeping those contacts*”.

Others identify the diversity of the network as important. One company respondent states: “*Connect facilitates making and keeping contact in a range of sectors, i.e. academic and public sectors, various industry sectors*”. Similarly, another respondent notes: “*The*

networking platform is very important in that it provides a solid mechanism for the biotechnology community to network with other stakeholders”.

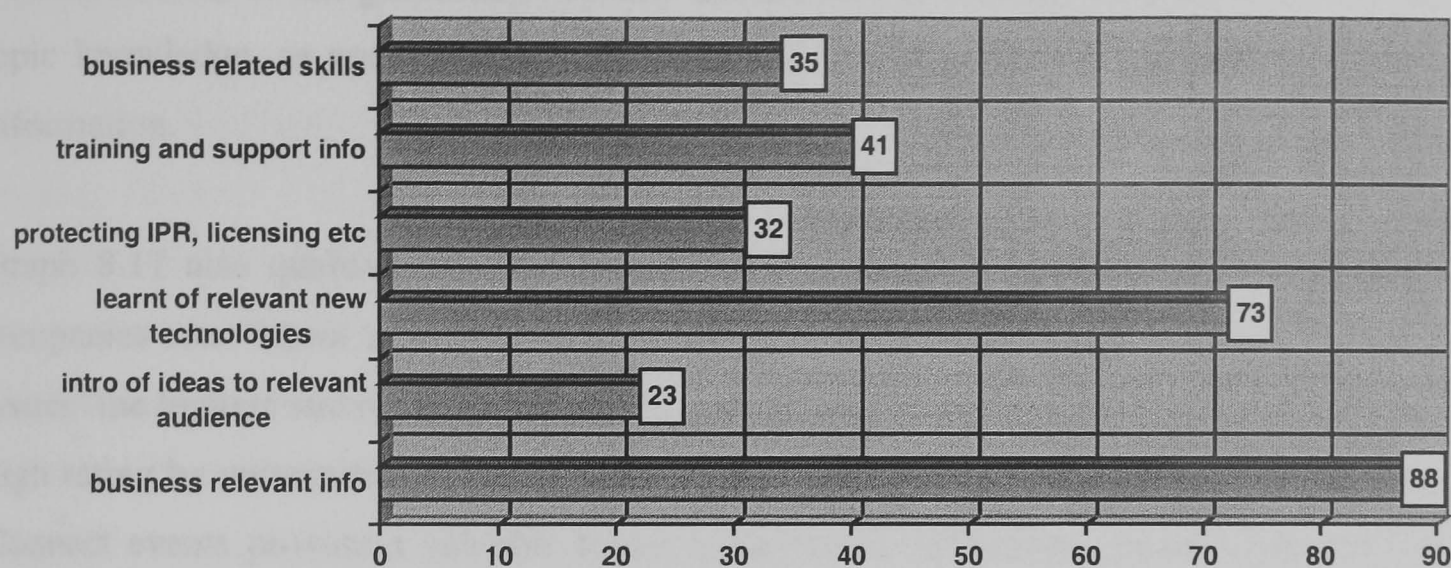
Companies identify Connect as a social environment that is conducive for business. An informal atmosphere at events is identified as facilitating interaction between service providers and companies. One respondent states: *“Connect is well-suited for doing business and facilitates it well; there is no problem flashing business cards at the events; Connects is good at managing these different interests”*. Another indicates that: *“Connect is the most relevant network for potential business because of the overlap of potential clients of [our company] and the Connect attendees”*. Indeed, results identify partner contacts as the most important social value for companies.

A third theme expressed by company respondents is the importance of Connect as a venue for like-minded entrepreneurs experiencing similar issues and difficulties. One comment suggests: *“Connect reflects a shared vision of everyone of future success of start-ups”*. Another respondent identifies a recurring comment among a few of the newer network members by stating *“It is a place to meet different people that share similar experiences...it’s lonely as an entrepreneur”*.

8.4.2.2.2 Knowledge Value

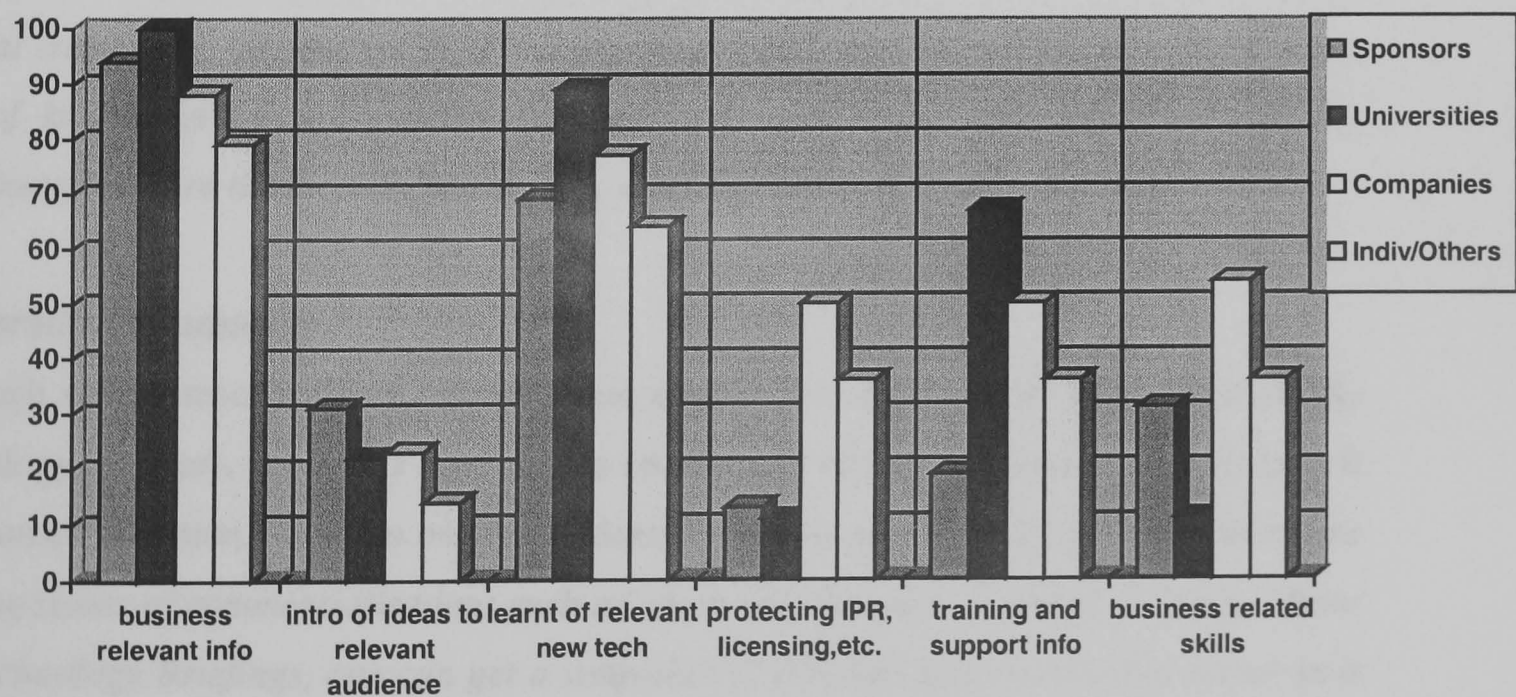
Graph 8.16 shows a more varied pattern of responses to knowledge value indicators in comparison to social value. Although it would be expected that learning of ‘relevant information’ and ‘relevant technologies’ for their business would be highly rated knowledge indicators, the lowest rated questions reflect issues most relevant to commercialising technologies, such as ‘learning about business-related skills’, ‘IPR and licensing issues’. To reiterate, an objective of Connect’s recurrent events to facilitate transfer of commercialisation knowledge.

Graph 8.16: Affirmative Responses to Knowledge Value Indicators (n=67)



Another key observation Graph 8.16 is the low rating given to the question ‘introduced my technology to a highly relevant audience’. Another objective of recurrent events is to provide a networking forum for exposing new technologies to potential supporters. These findings require further qualification by stakeholder category in Graph 8.17.

Graph 8.17: Affirmative Responses to Knowledge Value Indicators by Stakeholder Group (n=67)



Graph 8.17 confirms the low rating given to the question “introduced my technology to a highly relevant audience” by companies and universities, two stakeholder groups expected to benefit from the recurrent event forum. This finding may suggest that an appropriate

technology audience is not available at recurrent events or that the forum provided by recurrent events is not generating business discussion and activity but is rather delivering topic knowledge, as noted by the high ratings of business relevant and new technology information.

Graph 8.17 also qualifies commercial support perceptions of stakeholders, and indeed, companies rate ‘learnt about business-related skills and ‘learnt about IPR and licensing issues’ the highest among stakeholders as expected. An interesting finding, however, is the high rating by universities to ‘learnt about training and support programs’, suggesting that Connect events provide a valuable forum to university technology transfer personnel in updating them on external support programs.

Sponsor Comments

Two themes emerge from sponsor comments on the perceived knowledge value of Connect. The first is the use of Connect as a training venue for staff, as noted below: *“Connect allows us to expose staff to industry sectors to increase their knowledge; with the intention of eventually giving sector advice to clients”*. The second theme is the role of Connect as a knowledge provider, with Connect facilitating, as one sponsor said, the *“lateral transfer of information”*. Other comments include: *“[Connect] breaks down the lack of knowledge; a key problem in Scotland”* and *“[Connect allows for] market awareness, who are the players, angels, etc. and what is innovative in Scotland”*.

University Comments

Although survey results identify a low value attributed to commercialisation topics (IPR, technology transfer), university respondents commented on the importance of information on commercialisation issues, as one respondent states: *“to gain insight into how others are tackling issues of commercialisation; such as where are the gaps”*? Another states: *“from the Technology Briefings, one can get a snap-shot of a technology or industry sector in a single session”*. One university respondent identifies a more general benefit, stating *“Connect facilitates a greater awareness of various institutions and agencies and how they operate”*. Related to the previous comment is a further statement: *“Connect provides*

practical knowledge on how to do something; this differs from experience with the civil servant mentality”.

Company Comments

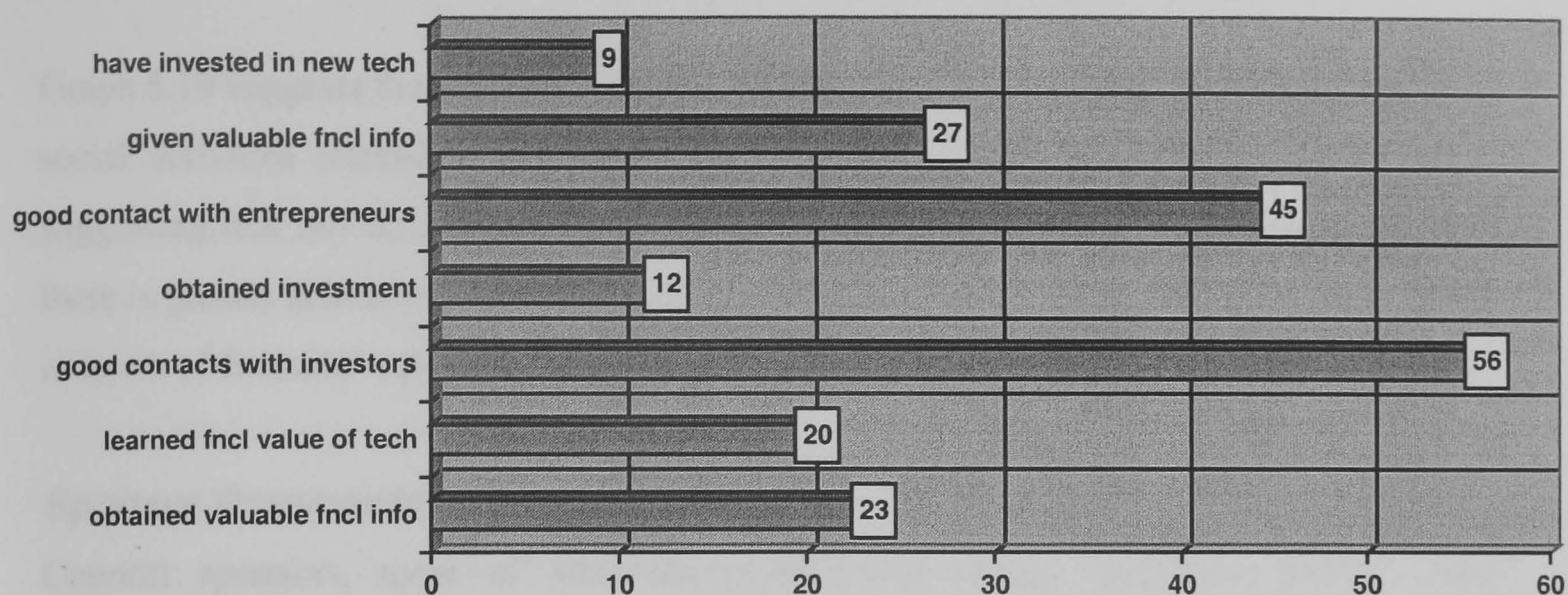
Sharing business experiences with other entrepreneurs was the most frequent comment from companies. Three company respondents note the value of hearing about other people’s experiences in setting up businesses and the problems they have encountered. Companies were also interested in sector-specific information, as noted by one respondent: *“Connect provides a cross-sectoral venue as well as relevant topics according to industry sector”.*

Other comments identified learning being facilitated through Connect through an evolutionary staging of topics at events with different issues raised and discussed. A number of company respondents cited information that related to specific commercial issues they were experiencing at the time (e.g. *“last year’s seminar on insuring businesses was highly relevant and informative”*). Company respondents, despite the high percentage of spin-outs, did not identify knowledge from universities as important despite the high rating given by universities to ‘gave valuable advice’.

8.4.2.2.3 Financial Value

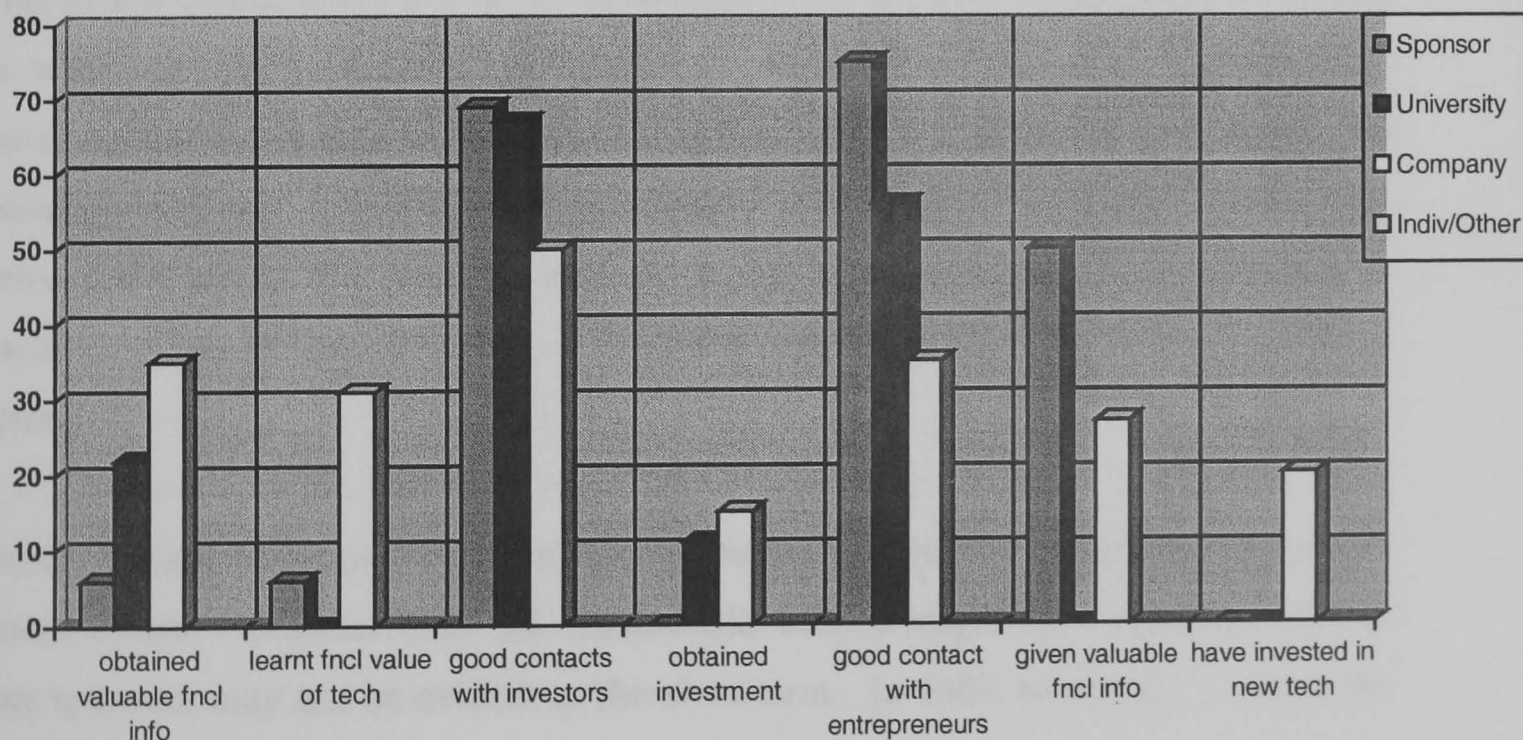
Graph 8.18 identifies the Connect network as most valued for social contact with investors and entrepreneurs, although these two primary financial indicators are not as strong as the respective social and knowledge indicators. Respondents also confirm a lower level of financial knowledge exchange, as seen in responses to ‘gave valuable financial information’ and ‘obtained valuable financial information’. More tangible financial value is not apparent based on the response level to ‘obtained financial backing’ and ‘invested in new business’, with both these indicators rated the lowest. As expected, the number of respondents perceiving value decreases as the indicators imply a more demanding value. Contacts between investors and entrepreneurs are being facilitated at events but attribution of deals being made is not confirmed according to these indicators.

Graph 8.18: Affirmative Responses to Financial Value Indicators (n=67)



Graph 8.19 shows high level of investor and entrepreneur contact among sponsors and universities as expected and to a lesser extent by companies. Sponsors also identify a high provision of giving valuable financial information at events.

Graph 8.19: Percentage (%) of Affirmative Responses to Financial Value by Stakeholder Category (n=67)



An interesting observation from Graph 8.19 is that company respondents rate 'invested in a new technology' higher, suggesting that company members are also active in investment.

It would be expected that companies and universities would rate 'obtained investment' higher than sponsors, as they are more explicitly seeking investment.

Graph 8.19 suggests that overall, company members of the network are actively engaged in social activities related to investment that includes seeking and providing investment, suggesting that not all company respondents are emerging start-ups. It also appears that there is greater selectivity on the part of sponsors and universities to what they are seeking in terms of financial value that is limiting their level of financially-biased social exchange.

Sponsor Comments

Connect sponsors, most of who are professional service providers, identify their expectation of securing clients through early contact with technology entrepreneurs. One sponsor comments: *"[We] want to see potential clients early to develop long-term relationships; our prime motivation is to increase the number of clients"*. Similarly, another explains: *"Although most new ventures can't initially afford [us], Connect is a link to get to know potential clients of the future"*.

Sponsors also comment that, in return for 'complementary' business knowledge they provide to new companies at events, entrepreneurs will feel a level of obligation to contact them when seeking professional services. As one sponsor explains: *"By providing business advice, it is hoped that clients will develop a moral obligation for a long-term relationship with us"*. Another sponsor suggests a level of compatibility between the objectives of Connect and sponsors, stating: *"Connect is supportive of new ventures, in line with the focus of [our company], who want to support and provide services for these companies"*

However, few sponsors could attribute any new business directly to attendance to Connect recurrent events. Connect CEO Ian MacDonald acknowledged that direct benefits to private sponsors may not be evident in the short-term. In 1997 he stated, *"...From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years."* It is argued here that an

identified challenge for Connect will be to *“increase the financial value delivered by the program as perceived by its private sponsors”*.

Sponsors also identify the importance of the investment events in stimulating interactions between young technology companies and potential investors, with a number of suggestions that the Springboard event was a needed program for filling the gap for very early stage companies.

University Comments

Universities are unanimous in stating their expectation of attracting investment for the technologies they represent at Connect events. Commercialisation officers representing three universities explicitly stated these intentions. One states: *“[Our] university already has technologies waiting to go”*, while another explains: *“Through Connect we hope to expose enough of our technologies to secure financial backing for university technologies”*. A third offered a simple explanation for his attendance: *“I want to meet potential funders for our technologies”*.

Survey results identify a low value associated with ‘obtained investment’ by universities, although a few respondents stated their expectation that investors will be found. As one commercialisation officer states: *“we have yet to obtain financial backing for ideas/products but expect to in the future”*. Others stated their concern that investment was not forthcoming, suggesting an impatience and level of expectation that Connect events would facilitate more tangible financial value.

University expectations of financial returns through network participation are more direct and explicit than sponsors and companies. As will be discussed later, these expectations and the role of universities with other stakeholders are factors influencing their realisation of financial returns. It will be further suggested that these factors contribute to the difficulty in identifying Connect’s original targets (e.g. spin-outs, collaborations) as these targets will reflect the strength of university relationships with other stakeholders.

Company Comments

Entrepreneurs and company representatives identify their expectations of finding investors and partners for their technologies and getting general financial advice, supporting survey results that identify companies absorbing financial value across all financial indicators. Introductions by third parties was noted as an important aspect of establishing contacts with investors at events and being introduced to new business prospects.

A number of comments allude to the quality of the investment conference, with recommendations that it should be held every 6 months instead of annually because of the frequency of start-ups. Others suggest that the profile of the investment conference in attracting foreign investors to Scotland is particularly important for their technologies, fearing that appropriate investors are not available locally.

8.4.2.3 Stakeholder Recommendations from 1999 Survey

Stakeholders in the 1999 survey were asked: *“if you could make any changes to the activities and organisation of Connect, what would they be and why?”* General themes and specific recommendations by stakeholder category are described below.

8.4.2.3.1 Sponsors:

♦ *More Entrepreneurs at Events*

Many sponsors noted that often the number of entrepreneurs at events is not large; therefore it is disappointing for service providers looking for opportunities to develop relationships with new businesses and other stakeholders. It was noted that there is a shortage of both entrepreneurs and venture capital in Scotland, perhaps due to the size of market and geographical situation.

◆ *Managing Sponsor Expectations*¹⁸

A number of sponsors cautioned that Connect should not promote the network to prospective sponsors simply as a 'deal-flow' venue, as many new companies in attendance are not able to afford such services. Two sponsors suggested that there should be greater selectivity in sponsorship; there is a question of whether or not the sponsors really matter. One sponsor noted that Connect must deliver value for its sponsors, while another stated: "*[our company] sees their role as a sponsor to be more active with Connect; with the goal of trying to get a more strategic role for Connect, i.e. business leader forum that focuses on skills for new venture start-ups*".

◆ *Connect Needs a Focused Differentiation Strategy*

Many sponsors suggested that, with the proliferation of support programs for start-ups, Connect must differentiate itself from other organisations such as Business Forum (which acts more as a sounding board for entrepreneurs). This includes more actively promoting the features and benefits of the network to the Scottish business community and the sources of start-ups such as universities and research institutes.

Sponsors also provided specific recommendations for Connect. One sponsor suggests that some entrepreneurs are not natural-born 'networkers', so an introductory session on networking would be valuable. Another suggests that many new companies have gaps in their management teams, so one session could discuss how to attract non-executives, and how to create a board; while another session recommendation is to bring in an experienced chairman to discuss strategic direction and how to access investment.

Another sponsor emphasises the importance of dialogue across different support programs and a "*cross-fertilisation for learning and knowledge sharing for Connect's long-term survival*" that would include program such as Connect San Diego and local programs such as First Tuesday.

¹⁸ Already identified is the expectation that sponsors will be seeking more tangible benefits such as an attributed deal flow arising from their participation within the network, suggesting that their role within the network will evolve from supportive and passive to proactive and needs orientated.

8.4.2.3.2 Universities:

- ◆ *Connect should play a more hands-on role in championing the university technology environment*

Universities identified the need to improve collaboration between universities and those supporting technology exploitation. One respondent explains that “*Connect should develop a “showcase” for new start-ups at the universities... a baby version of investment conference to act as a springboard, (but don’t mention investment)*”. More focused commercialisation events for technologies were suggested, such as product marketing by sector, e.g. software, biotechnology, and providing sessions on branding, company law and human resource issues.

- ◆ *Governance of Connect should be more transparent*

Governance issues were raised that included the need for more communication with Connect’s Advisory Board and increasing the accountability of the Board (i.e. the need for a recognised business plan). One respondent questioned whether or not Connect’s mandate is changing, by asking where public sponsors fit and the role of the European Union and SHEFC (Scottish Higher Education Funding Council) as the primary funders of Connect.

- ◆ *Leverage the political neutrality and integrity of Connect*

University respondents identified the importance of Connect as a unique support forum in the Scottish context. One respondents explains that: “*Connect is a platform that provides integrity and confidentiality; therefore allowing it to offer a diverse range of services*”. Another suggests that: “*Connect is out of the political fray and needs to stay that way*”!

8.4.2.3.3 Companies:

◆ *Clarify Connect's Distinction from other Support Initiatives*

Companies identify the proliferation of support programs and the need for Connect to identify to prospective companies its distinction, similar to sponsor recommendations. One respondent suggests: *"there is a need for Connect to be specific to new ventures, as it is "a minefield out there for entrepreneurs"*. Respondents also suggest that Scotland needs to focus on small firms, not growing global giants and that Connect, as one respondent suggests *"needs to champion the realisation of value in small firms, and help grow new firms"*.

◆ *Promote More to University Researchers*

A common recommendation is getting more people from the university out to events, especially post-doctoral students, *"as they have the highest potential to leave the university to form a spin-out venture"*. Two respondents noted that Connect is a good tool for training scientists about commercial possibilities but one of them argues that there are university 'gatekeepers' of Connect information that do not adequately forward information on Connect. This respondent suggests that Connect develop a database of individual researchers that can receive information directly from Connect.

◆ *Facilitate Flow-through of Companies in and out of Connect*

Company respondents suggested the need to track what happened to companies that left the network to identify what have they gained and where they are going to get more information, advise and support. One respondent explains that: *"the dynamic nature of business support requires a continuous assessment and refreshment of ideas for program's content and mechanisms"*.

Related to tracking 'graduate' companies were suggestions that Connect be more explicit in their partnerships with other support agencies and private sector partners. Companies identify a 'value curve' with Connect providing high value early on in the start-up phase of the company and less value later on, as explained by one

respondent: *“I have plateaued in what I can get out of Connect; things are new at the outset, as in the Law of diminishing returns in Scotland; get to know everyone and run out of things new and different”*.

One respondent of an established company suggests that Connect is at a stage where they need to diversify. Another comment asked whether Connect has overextended itself (event fatigue), and the respondent suggests Connect may need to have fewer events with more impact.

Conversely, another argues that Connect should more actively recruit new members rather than cater to established companies, stating: *“I am seeking out different things now and use the Business Forum among others; Connect thus needs to encourage new people to come along to events, as Connect shouldn’t be for established firms... the purpose for Connect is to “get you going”*.

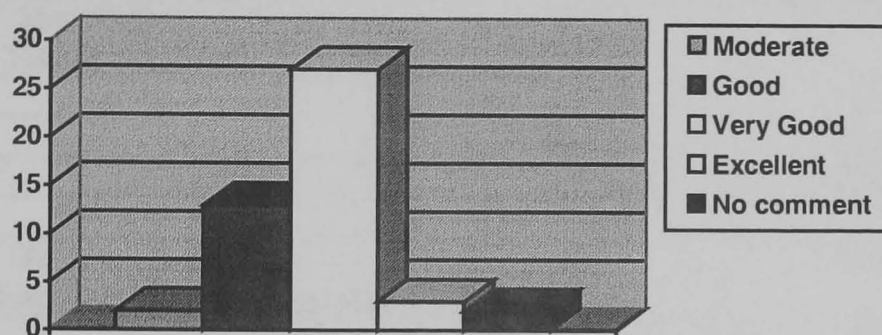
Company recommendations stress the need for Connect to continually refresh their event content and clarify how Connect fits among other support initiatives that members are involved with. Another challenge for Connect is whether to remain focused on new companies or to expand and diversify events to meet evolving needs of companies as they emerge from successful start-up and seek growth-related information and knowledge.

8.4.3 Stakeholder Perceptions of Network Value (2001)

8.4.3.1 Event Quality

Graph 8.20 identifies a slight decrease in the overall quality rating of network events, 80%, in comparison to 86% in the 1999 survey. This rating remains above the original target set by Connect to ensure all events are rated *very good* or at the level of 75%.

Graph 8.20: Quality of Connect Events (n=49)



8.4.3.2 Changes to Network Value Flows: Comparing 2001 and 1999 Survey Results

This section compares 1999 and 2001 survey results using SPSS cross-tabulation and Pearson's chi-square to qualify the significance of changes to social, knowledge and financial value dimensions and to each of the 20 contributing value indicators. Survey data has been 'cleaned' by removing 'not-applicable' responses and collapsing the non-affirmative responses ('not so far', 'not so far but I expect to in the future', and 'not at all') into a single category, that creates three categories that include 'most definitely realised' and 'realised to some extent' affirmative categories.¹⁹

Table 8.4 compares affirmative responses to each of the three value dimensions between the 1999 and 2001 from which a number of observations related to each value dimension can be made. Affirmative responses to social value have remained proportionally the same between both surveys, decreasing in 'most definite' and increasing in 'to some extent'

response categories by almost identical levels (7.1 and 7.0) in 2001. In contrast, affirmative responses to knowledge value have increased proportionally in 2001, the result of a greater increase in the ‘most definite’ response category than decrease in the ‘to some extent’ category. Affirmative responses to financial value demonstrate the most proportional change between surveys and produce the most statistically significant chi-square value.

Table 8.4: Comparison of 2001 and 1999 Surveys: Network Value Dimensions

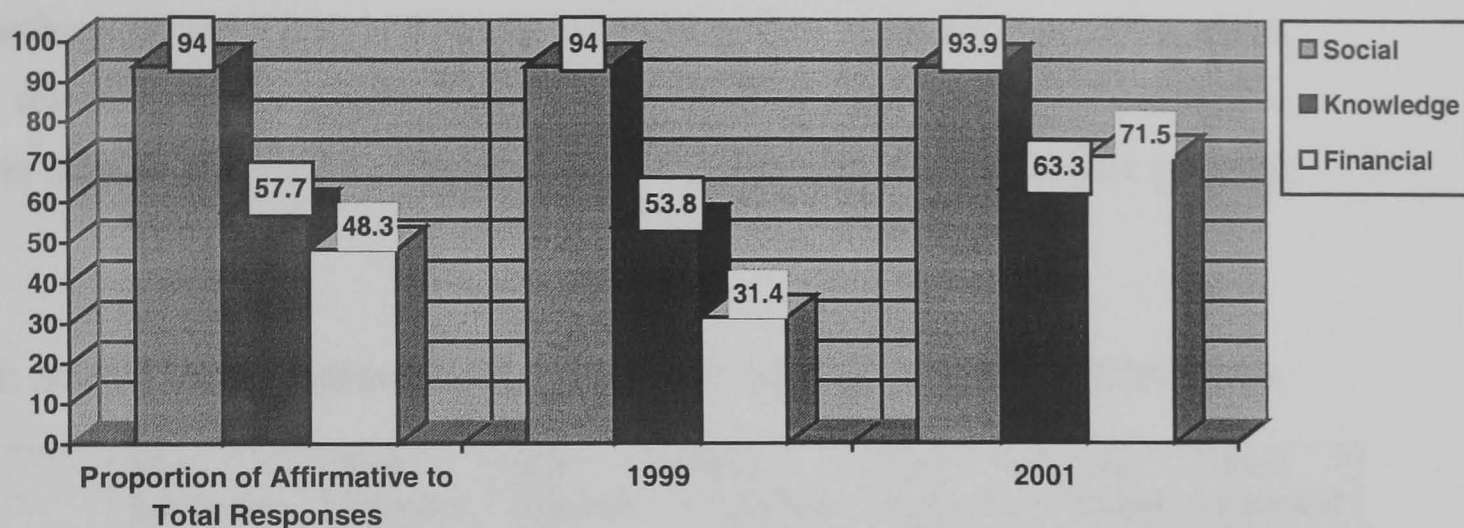
Value Dimension	Social	Knowledge	Financial
Proportion of ‘ <i>Most Definite</i> ’ Affirmative Responses to Total Responses	38.8	12.9	11.2
1999 Survey	41.8	7.5	6.0
2001 Survey	34.7	20.4	18.4
Change	-7.1	+12.9	+12.4
Proportion of ‘ <i>To Some Extent</i> ’ Affirmative Responses to Total Responses	55.2	44.8	37.1
1999 Survey	52.2	46.3	25.4
2001 Survey	59.2	42.9	53.1
Change	+7.0	-3.4	+27.
Pearson Chi-Square Value	9.952	4.350	18.526
Degree of Freedom	2	2	2
Assumption Significance	.051	.114	.000
Linear-by-Linear Association	3.747	3.044	16.615

Graph 8.21 uses data from Table 8.4 to show that knowledge and financial value have increased in greater proportion to social value. Although social value retains the greatest proportion of affirmative responses overall, this level has decreased slightly in 2001 while the proportional difference between social value and knowledge and financial value has reduced. A further observation in graph 8.27 is that financial value has overtaken knowledge value in terms of total affirmative responses.

Identified earlier in section 8.4.2.2 was the challenge in 1999 for Connect to increase knowledge and financial value as explicit benefits to be gained by stakeholders actively engaged in the network. Clearly, Table 8.4 and Graph 8.21 suggest that this increase in knowledge and financial value has occurred while maintaining a consistent level of affirmative social value.

¹⁹ This reconfiguration of response categories provides a robust assessment of the survey data set while focusing on affirmative changes to network value dimensions rather than evaluating the survey tool itself.

Graph 8.21: Changes to Network Value Dimensions: Total Affirmative Responses and Comparisons with 1999 and 2001 Responses
 ('most definitely realised' and realised to some extent' responses combined)



These proportional changes to Connect's three value dimensions support earlier assumptions that business-related exchange is occurring at a greater level within the network overall in 2001 as compared to 1999. Returning to network evolutionary literature, this change could be the result of various factors. One explanation, based on the higher level of social value in 1999, is that social investment activities of individual stakeholders are now realising specific business benefits (Birley 1985; Burt 1992; Johannisson 2000;). However, two different samples of stakeholders have been used in the 2001 and 1999 surveys, making it difficult to confirm that social relations are a precursor to knowledge and financial value specifically at the individual level.

Another explanation is that Connect as a network manager is evolving into a more efficient facilitator of business exchange (Hakensson and Snehota 1995). Connect's high retention rate of sponsors may be developing into a supportive network community more elaborately connected and willing to facilitate knowledge and financial value exchange more readily amongst themselves. Greater familiarity among institutions and their staff at events may in turn facilitate a greater level of knowledge and financial value exchange between sponsors and members.

The following sections examine each value dimension and related value indicators to qualify the changes to social, knowledge and financial value dimensions described above.

8.4.3.2.1 Social Value

Table 8.5 identifies proportional increases in more demanding social indicators of ‘met potential backers of my idea’ and ‘gave valuable advice’ compared to 1999 where affirmative responses accumulated towards less demanding indicators. Less substantive increases are seen in affirmative responses to ‘met potential partners’ and ‘met potential clients’.

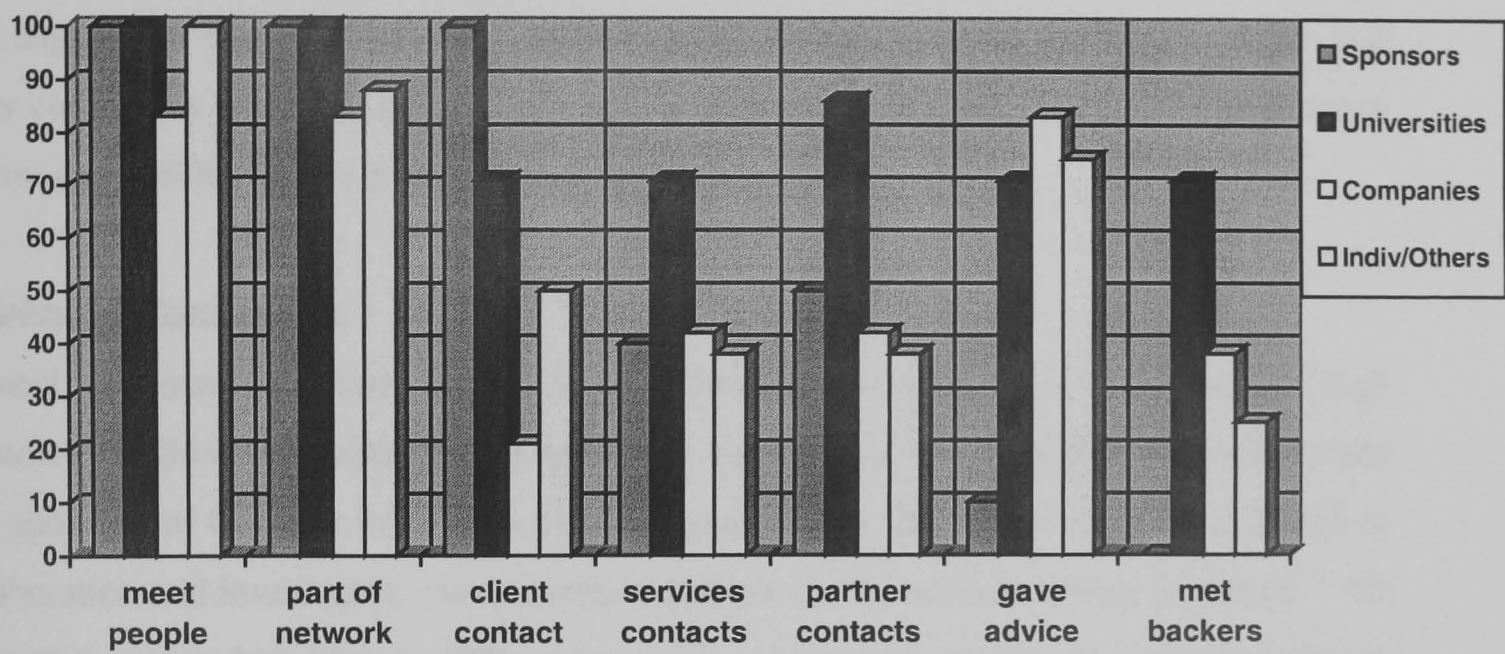
Table 8.5: Social Value Indicators: Comparison of 1999 and 2001 Affirmative Responses

Indicator	Met Interesting People	Feel Part of a Network	Met Potential Clients	Met Potential Service Providers	Met Potential Partners	Gave Valuable Advice	Met Potential Backers
Proportion of ‘To Some Extent’ Responses to Total Responses	41.6	48.2	29.2	34.0	29.2	46.7	29.9
1999 Survey	47.7	46.8	25.8	32.8	25.4	40.4	25.6
2001 Survey	33.3	50.0	35.3	35.6	34.0	53.5	35.3
Change	-14.4	+3.2	+9.5	+2.8	+8.6	+13.1	+9.7
Proportion of ‘Most Definite’ to Total Responses	51.3	39.1	25.0	16.5	21.7	17.8	7.8
1999 Survey	44.6	37.1	21.0	19.0	25.4	14.9	4.7
2001 Survey	60.4	41.7	32.4	13.3	17.0	20.9	11.8
Change	+15.8	+4.6	+11.4	-5.7	-8.4	+6.0	+7.1
Pearson Chi-Square Value	2.793	1.495	3.903	.586	1.516	3.585	2.695
Degree of Freedom	2	2	2	2	2	2	2
Assumption Significance	.247	.474	.142	.746	.469	.167	.260

Findings in Table 8.5 suggest that increases in more demanding social value indicators are the result of improved levels of social exchange within the network. Indeed, Graph 8.22 shows increases in social exchange indicators in the 2001 survey for sponsors, where client contact responses have increased, while for universities, client, service provider and partner contacts have all increased. Similar to the 1999 survey, sponsors rate client contacts highest while universities rate partner contacts highest. Indeed, the level of increase in social exchange indicators in 2001 could suggest that universities are taking a more active approach to social relationship building. Overall, it appears that universities and the individual/other category are the primary benefactors of the increase in affirmative

social exchange value identified in 2001, with both categories showing an increase in affirmative responses to ‘met potential backers of my ideas.

Graph 8.22: Survey 2001: Affirmative Responses to Social Value Indicators by Stakeholder Group (n=49)



Sponsor Comments

Sponsors in 2001 continue to view Connect as a valuable forum for social exchange, as one sponsor calls it, “an inexpensive network that creates good dialogue for support”. Another sponsor identifies the social and business networking benefit of Connect, stating: “I expect to meet with entrepreneurs and have exposure to new technology business ventures, while also networking with peers. My perception is that Connect operates most effectively as a support network for new business”.

However, sponsors in 2001 identify their expectations of benefits arising out of their participation. One sponsor states: “We expect to raise our company profile in the technology sector by being active contributors in helping Connect reach its goals locally”. For some sponsors, there were identified concerns raised over Connect’s role in facilitating the needs of certain technology sectors such as oil and gas. One sponsor identified the concern over linkages with SMEs and new technologies. He states: “Our expectation was that we would, through Connect, be able to access and develop networks with SMEs who are developing technologies, not traditionally associated with, but with the potential for application to the upstream oil and gas sector. It may need more energy on both our own

and the part of Connect to bring the appropriate parties together. But to now I'm afraid the information sent to me by Connect has not sparked off any possibilities. Maybe Connect needs to act more proactive and begin to facilitate this interaction - our company after all spends around [large sum] per year in Scottish-based businesses".

This suggestion that Connect facilitate linkages between new technologies, SMEs and larger companies identifies a key challenge for Connect and Scottish support initiatives in general and will be further discussed in Chapter Ten.

University Comments

Connect continues to provide access to an informed network of key supporters of high technology in Scotland, according to university respondents. With all Scottish universities now sponsors of Connect in 2001, a shared expectation is that social contacts will lead to collaboration and investment. As one respondent put it: *"Good networking is pivotal."* Or as another respondent puts it: *"We want to see a vigorous market in technology-based industries in Scotland. We expected Connect to play a significant part in support this market by bringing together relevant communities. These expectations have been met to some extent."*

Connect is also identified as delivering social value to universities beyond the central belt of Scotland where most are located, as explained: *"In general, Connect provides a good service in Aberdeen. It provides a good meeting forum and helps to link those interested in technological innovation and providing services."*

Company Comments

Company comments on social value were more diverse in 2001 than 1999. One theme continues to highlight the progression of initiating and developing social relationships that may lead to business relationships. Related comments include: *"I expect the Connect network to provide contacts for partners, investors and customers"*. Another states: *"The Connect forum is great. I have found its meetings very well organised and useful from a networking point of view"*. Similarly, *"Connect is a valuable organisation that has a key role to play in generating and delivering new opportunities-business, employment, wealth creation and re-investment"*.

A long-standing company member offers an overview of the value of Connect: *“I have been involved with Connect in a variety of ways since the development of the concept and have always enjoyed my interaction, either from an audience perspective or as an assisting party for Springboard and the Investment Conference. Connect does a good job bringing technology people in contact with business angels and to increase awareness of the sector and our expectations are to continue to have links with other new technology companies”*.

Other companies expressed difficulties in benefiting from Connect either because of geography, or because their business activity was not closely related to Connect’s focus. Thus, one respondent comments that: *“being based in the Highlands, it is difficult to make the most of being a member of Connect. My perception of Connect in supporting high technology start-ups is that the company has to be based in a main centre to reap full benefits.”*

In turn, a respondent whose business did not seem to relate to Connect’s focus stated: *“I have met some very interesting people through Connect although as yet my business (business development in marketing and sales) has not directly benefited. This is probably down to me and my lack of involvement in high-technology business. However, it may happen yet”*.

Unlike the 1999 survey, some company respondents in 2001 expressed outright dissatisfaction with the social value delivered by Connect Scotland. One respondent simply states that *“Connect tends to be clicky”*. Another experienced entrepreneur voiced his dissatisfaction, stating: *“Speaking as a high-technology entrepreneur with 20 years of experience of building high-technology companies from scratch, I have found the Connect experience disappointing. While the technical meetings are enjoyable and informative, as a networking forum, I find it pretty useless. It is also very measured, typically Scottish and ultimately, boring. I was hoping to meet people with good technical ideas who could benefit from my experience, particularly in sales and marketing. Perhaps I am wrong, but I thought the idea of Connect was to bring people together, spark off new ideas and help build a lively, vibrant, Scottish high-technology scene. At this rate, we will catch up to Silicon Valley some time in the next millennium”*.

Another disgruntled participant states: *“Whilst I accept that the real problems are elsewhere in ‘the system’, after such early promise to ‘break the mould’, I am very disappointed in how things have panned out, re: being in Connect”*.

8.4.3.2.2 Knowledge Value

Table 8.6 identifies a proportional increase to the more demanding knowledge indicator of ‘introduced my technology to a relevant audience’. The low affirmative response to this indicator in 1999 prompted concerns that company members were not identifying the Connect network as an effective forum for showcasing their technologies. This increase in 2001 could indicate that a more appropriate technology audience has developed at recurrent events, either by chance or through a more active role by Connect in matching companies and sponsors.

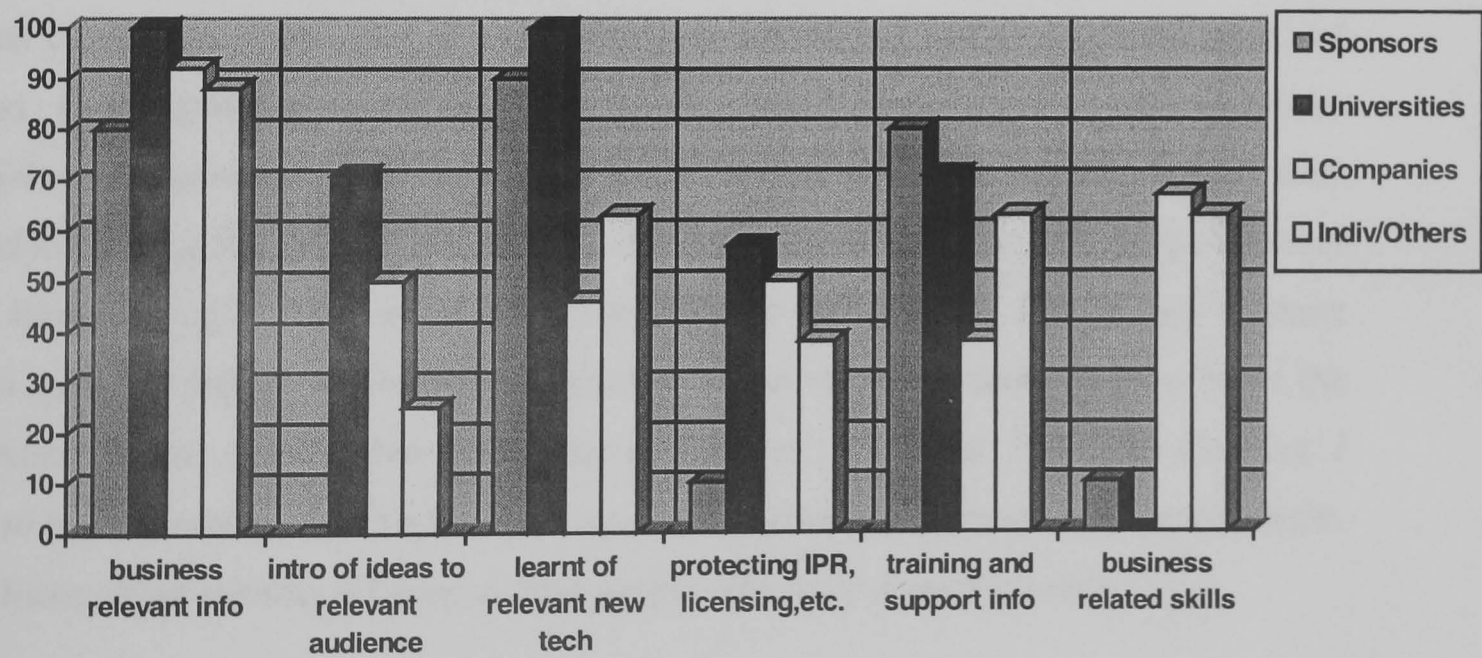
Table 8.6: Knowledge Value Indicators: Comparison of 1999 and 2001 Affirmative Responses

Indicator	Learnt of Business-related Information	Introduced Business/ Technology to Relevant Audience	Learnt of Technologies Relevant to my Business	Learnt of Protecting IP, Licensing, etc.	Learnt of Training and Support Programs	Learnt Business Skills
Proportion of ‘To Some Extent’ Responses to Total Responses	47.7	22.4	51.9	35.6	50.5	40.0
1999 Survey	54.0	15.9	60.0	32.7	50.0	36.0
2001 Survey	39.6	31.3	41.3	39.5	51.1	45.7
Change	-14.4	+15.4	-18.7	+6.8	+1.1	+9.7
Proportion of ‘Most Definite’ to Total Responses	45.9	23.7	24.5	13.8	7.2	14.1
1999 Survey	41.3	20.5	21.7	14.3	5.8	12.0
2001 Survey	52.1	28.1	28.3	13.2	8.9	17.1
Change	+10.8	+7.6	+6.6	-1.1	+3.1	+5.1
Pearson Chi-Square Value	2.425	4.228	3.832	.436	.433	1.862
Degree of Freedom	2	2	2	2	2	2
Assumption Significance	.297	.121	.147	.804	.805	.394

Table 8.6 shows that business-related knowledge and information on relevant technologies remain the two most highly rated knowledge indicators. However, a noticeable decrease in proportional affirmative responses to these two indicators is an unexpected finding. This finding could confirm some concerns voiced by stakeholders in the 2001 survey that Connect is not meeting the needs of certain sectors or over-emphasising others, suggesting the challenge for Connect in maintaining relevance to a broad constituency of technology sector interests. This drop in affirmative response rate could also suggest that event topics are losing their ‘newness’.

Graph 8.23 identifies an increase in affirmative responses to knowledge value by universities, particularly to ‘learned about information on IPR and licensing’, suggesting a more active role played by universities in the network in 2001. A more active role by the individual/others category is also suggested in 2001 by a noticeable increase in affirmative responses across all knowledge value indicators.

Graph 8.23: Survey 2001: Affirmative Responses to Knowledge Value Indicators by Stakeholder Group (n=49)



Sponsor Comments

Sponsors in 2001 are more explicit on the knowledge value of the network. A respondent sums up a number of comments on the use of Connect as a knowledge forum, stating: “Connect provides a useful network - it enables us to learn about new technology and new

technology businesses and to meet others who are also interested in assisting them.” Another respondent identifies the multiple role of the network, stating: *“We attend to learn more about the investment community in Scotland and to meet potential clients, as well as to impart specialist advice (this has not happened often!).”*

Sponsors continue to identify the value of Connect as a network for doing business. One sponsor identifies the proactive role played by companies seeking services, stating: *“Connect enables new companies to advertise for and attract help in commercialisation”.*

University Comments

Although comments from universities in 2001 were less frequent compared to 1999, one concern emerged regarding Connect’s provision of benefits to universities. One university commercialisation officer states that: *“Connect seems to be aimed more at business start-up needs than university needs. More advice on spin-outs, etc. would be useful.”*

Company Comments

Three common themes emerge in 2001 from companies, two of which are similar to 1999. The first emphasises Connect as a place to obtain advice and ideas on technologies and business. One respondent states: *“My expectation is that Connect carries on giving advice on all issues surrounding technology. I think that Connect has done a good job and I look forward to more of the same in the future”.* Similarly, another states; *“We judge Connect by the knowledge of technology and the contacts that we acquire. I think that Connect does an excellent job for technology companies”.* The value of events like the ‘meet the entrepreneur event’ is identified by another respondent, who says: *“Through Connect, I expect to learn about alternative business models and strategies for company development, and to learn about running a business from people who have done it already.”*

A second theme identifies a wider economic role played by Connect, summed up in comments from a long-standing company member. He states: *“Connect fills a key role in Scottish industry/commerce. The need to grow indigenous businesses and establish a go to market model is paramount. My expectation is to be able to play a role in helping new or start-up businesses in a consultative or non-executive director role”.*

A third theme voices concern over potential bias in knowledge provision towards some industrial sectors. One respondent comments of bias towards electronics and less relevance to biotechnology, echoing a previous concern regarding Connect’s lack of relevance to Aberdeen’s oil and gas sector. Another states: *“Connect occasionally comes up with ideas or technologies that I am interested in. Its heavy bias towards electronics means that it is less relevant to bio-technology than one would hope for.”*

Bias towards university technologies is also identified as a concern of another company member, who states: *“Connect is more directed to academic/university start-ups ... although I understand Connect is intended as a valuable resource for all start-ups needing contacts and advice.”* Indeed, similar to 1999, little evidence is identified from companies to suggest any significant level of value exchange between companies and universities.

8.4.3.2.3 Financial Value

Table 8.7 shows the financial value indicators contributing to the significant chi-square value attributed to the financial value dimension as identified in Table 8.4.

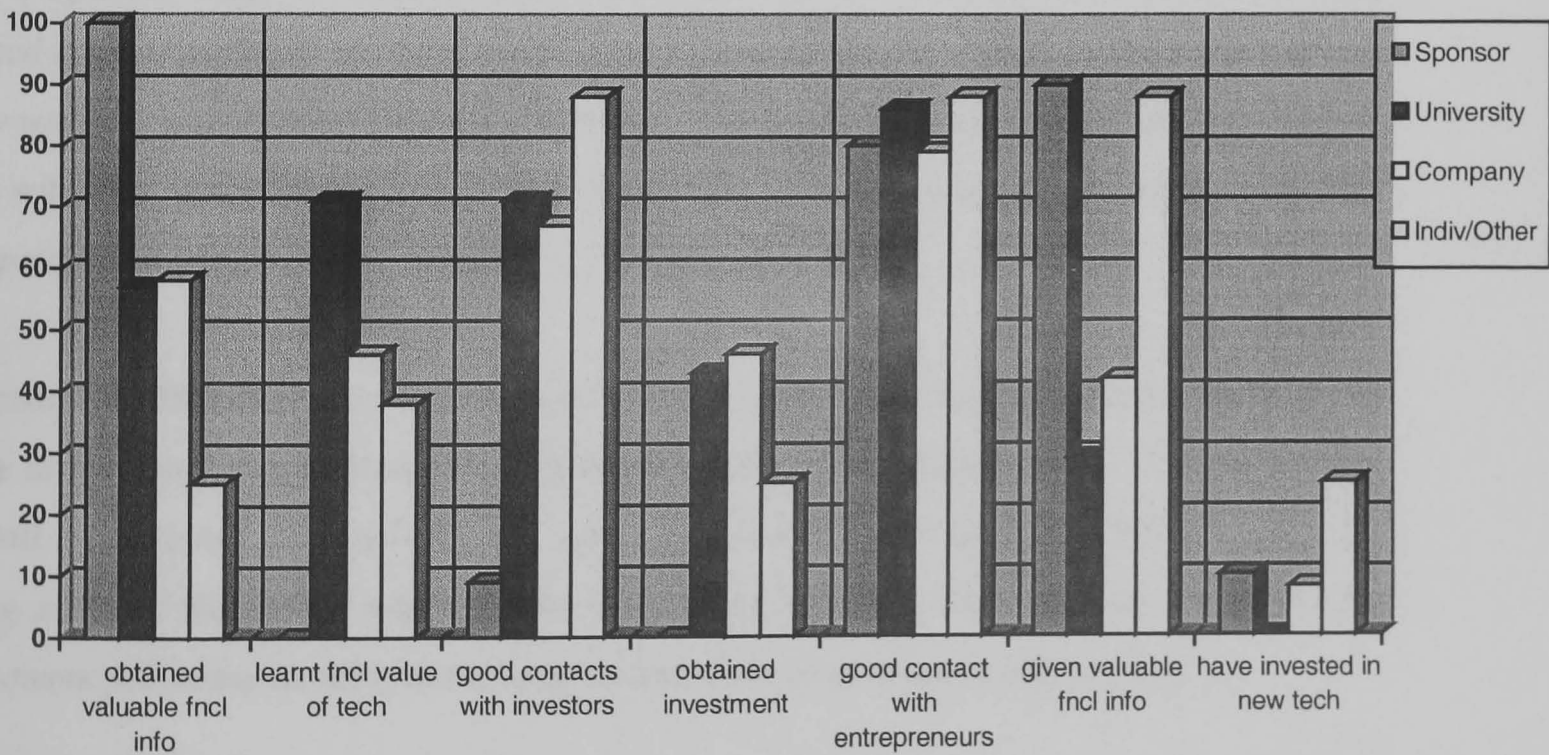
**Table 8.7: Financial Value Indicators: Comparison of 1999 and 2001
Affirmative Responses**

Indicator	Obtained Valuable Financial Info.	Learnt Value of Product/ Service	Good Contact with Investors	Obtained Investment	Good Contact with Entrepren	Gave Valuable Financial Info.	Have Invested
Proportion of 'To Some Extent' Responses to Total Responses	38.5	35.8	36.4	19.5	40.6	29.9	4.8
1999 Survey	32.0	28.9	36.2	15.9	31.0	32.6	5.4
2001 Survey	45.7	44.4	36.7	24.2	52.1	26.8	3.8
Change	+13.7	+15.5	+0.5	+8.3	+21.1	-5.8	-1.6
Proportion of 'Most Definite' to Total Responses	8.3	3.7	33.6	11.7	26.4	23.0	11.1
1999 Survey	0	0	29.3	2.3	22.4	6.5	8.1
2001 Survey	17.4	8.3	38.8	24.2	31.3	41.5	15.4
Change	+17.4	+8.3	+9.5	+21.9	+8.9	+35.0	+7.3
Pearson Chi-Square Value	14.200	6.988	1.596	10.975	10.749	15.668	.865
Deg. of Freedom	2	2	2	2	2	2	2
Assump. Signif.	.001	.030	.450	.004	.005	.000	.649

These results suggest that the network is more oriented to doing business in 2001 when observing proportional affirmative increases to more demanding financial indicators such as ‘obtained investment’ and exchange indicators of ‘gave’ and ‘received valuable financial information’. The proportional increase in social contact indicators i.e. with investors and entrepreneurs, suggests that high levels of social exchange indicators are related to investment. This assumption will be further discussed in the chapter summary.

Graph 8.24 qualifies above observations with response patterns by stakeholder category. Universities shows increases in ‘learnt financial value of technologies’ and ‘obtained investment’ and demonstrate the highest affirmative response increases on ‘making contact with investors’ and ‘learnt financial risks of my product’. At the same time, universities are identified with the lowest level of ‘gave valuable financial information’, supporting an earlier observation that universities are less active in reciprocal exchange activities.

Graph 8.24: Survey 2001: Affirmative Responses to Financial Value by Stakeholder Category (n=49)



Companies are identified with an increase in ‘obtained investment’ and ‘made good contact with entrepreneurs’. Further evidence of financial value is examined in section 8.4.4 where investment survey results confirm Connect’s more active intermediary role in linking technology companies with the investment community.

Graph 8.24 also shows a noticeable increase by private sponsors to ‘obtained valuable financial information’ yet a decrease in ‘made good contact with investors’. One explanation is the increased activity of individual members of the Connect network that also demonstrate a high level of affirmative responses to the indicator ‘have invested’. It is suggested that ‘business angels’ are playing a strong role in the investment arrangements stimulated by Connect Scotland. Indeed, it is estimated by Connect that between 8-12 individual members are private investors.

Sponsor Comments

Sponsors in 2001 continue to identify their expectation of deal flow from events. One sponsor states her expectations: *“As a sponsor, we would ideally like to get early sight of opportunities, and perceive of Connect as a ‘shop window’ for early stage opportunities”*. Any sponsor explains: *“Our firm expects to make contacts in the technology sector which will be a catalyst for new business.”*

Sponsors also identify that deal flow is not the primary criteria for participation at events. As one sponsor suggests: *“Opportunities to establish potential client relationships are very limited and virtually all of ‘new work’ comes from other sources. I’m not aware of any ‘new work’ won under the Connect umbrella. That said, it is a useful medium to keep up to date with this sector, know what young companies are up to and to tell people what [our company] is doing.”*

Sponsors in 2001 also identify Connect’s contribution to investment deals while at the same time identifying attribution of effect difficulties. A sponsor states: *“I am interested overall in business development and good investment opportunities. While others are doing some of the things which Connect does and Connect cannot claim credit for all investment following its investment conferences, I do think it has a role to play”*.

University Comments

University comments identify concerns over the level of exchange between universities and investors at events. As one respondent states: *“I feel that the level of engagement of*

academics talking about spin-outs and real venture capitalists have been a bit lower than I expected.”

Another university commercialisation officer offers his concerns: *“What I have not seen much of in Aberdeen, is the presence of potential investors at the meetings. Investors in technology and new start-ups are few in Aberdeen and even fewer seem to come to Connect meetings”*.

These comments add to the identified concerns by Connect stakeholders regarding the level of university-business interactions and managing the expectations of university sponsors through Connect.

Company Comments

Companies in 2001 continue to identify their expectations of finding investor at recurrent events. One company respondent commented *“My expectations are that I will meet potential investors. I feel that this has been achieved.”* Another respondent describes the value realised through investment events: *“The Connect Investment Conference definitely helped [my company] in its VC fund-raising experience”*.

Companies also identify the network itself as a reason for participation at events as this respondent explains: *“through membership in Connect, I expect to become part of a network of like-minded business professionals and expose my company to opportunities for partnership and development”*.

8.4.3.3 Stakeholder Recommendations from 2001 Survey

Analysis of stakeholder feedback from the 2001 survey identifies the following recommendations and challenges for Connect.

8.4.3.3.1 Sponsors:

- ◆ Enhance the speed and content of information flows and improve reporting to sponsors, especially regarding financial information.
- ◆ A forum for member companies that have ‘outgrown Connect’ is suggested, while at the same time ensuring that Connect makes its niche in the technology start-up market sustainable.
- ◆ Public sector sponsors stress the importance of Connect doing more in ‘other’ areas of Scotland (Aberdeen, Tayside) and making an impact.
- ◆ Monitor sponsor expectations, in particular private sponsors that may at some point require evidence that there are direct benefits returning to the company. Attendance patterns suggest that sponsors have begun to target their attendance to Connect events. Although the analysis clearly found indirect benefits were realised by sponsors (social and knowledge), some private sponsors in particular may need to demonstrate financial value. The investment conference and springboard events are attracting more sponsors. However, the value for new technology companies at recurrent events may be compromised if sponsors are not there providing the social contacts and advice.

8.4.3.3.2 Universities:

- ◆ Provide an informal forum to allow all university sponsors to voice their expectations and commercialisation requirements to facilitate a better understanding of needs. Evidence, from attendance patterns and value survey, suggests that there is much to be done to stimulate closer relations and interactions between university and business. The percentage of university attendees can be raised by greater interaction with organisations such as the Scottish Institute for Enterprise (SIE), to promote Connect events to university entrepreneurs and researchers.

8.4.3.3.3 Companies:

- ◆ Connect must maintain its open and friendly attitude and maintain neutrality in the newly independent organisation.
- ◆ Connect must continually improve its events, with a potential extra fee if needed to attract high quality speakers.
- ◆ Provide greater transparency in their reporting of activities to stakeholders. This issue is even more importance as an independent organisation moving out of Edinburgh University. A more systematic communication and consultation effort will enhance the constituency-building process by helping to make Connect the 'property' of all members of the constituency.
- ◆ Involve other support constituencies to help advance the public policy aim of program integration and simplification for more effective delivery of support to users.
- ◆ Connect should take on a leadership role in creating a global Connect Alliance. Establishment of Connect programs in Yorkshire and Warwick recently points to the importance of Connect Scotland as a leader in the field. Enhancing and strengthening these relation for purposes of knowledge sharing and cross-fertilisation of learning experiences is recommended. Despite the limited resources at the present time, Connect must leverage this position and be creative in exploiting their competitive advantage as a support program that others are emulating.

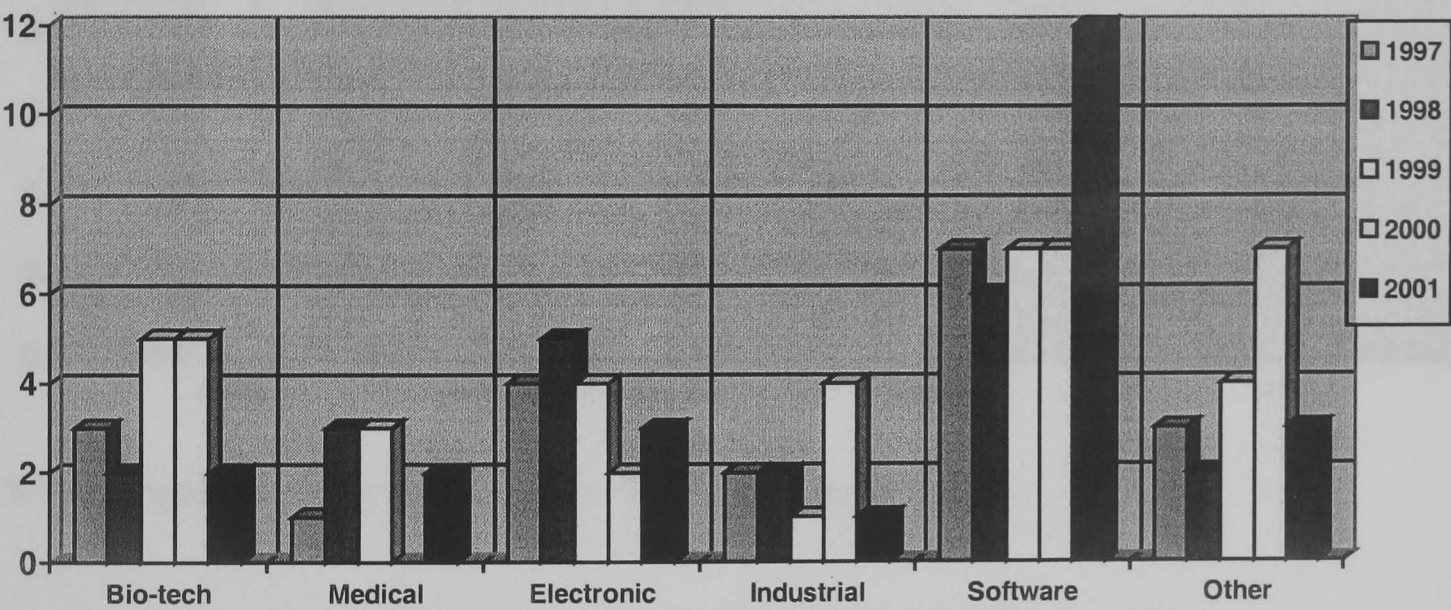
8.4.4 Investment Event Survey

This section examines benefits that presenting technology companies have attributed to Connect's Investment Conference. Companies that presented between 1998 and 2001 were contacted to respond to two questions pertaining to investment: (1) did you directly or indirectly gain investment through your participation in the Connect Investment Conference; and (2) is there a level of investment (% of amount sought or £ amount) that you can attribute to participation in the Conference? (survey results are in Appendix F).

8.4.4.1 Investment Expectations of Presenting Companies

Graph 8.25 shows the breakdown of sectors represented at each of the 4 conferences, reflecting the heterogeneous nature of new technology companies seeking funding in Scotland. With a limited investor base for technology in Scotland, it can be argued that bringing together these companies and investors to a single event provides efficiencies in scale and centralises a critical mass of investors to focus on a critical mass of companies to make it worthwhile for both groups.

Graph 8.25: Presenting Companies by Sector, 1997-2001
(‘other’ category (far right) is comprised of primarily e-commerce ventures)



Graph 8.25 shows that ‘software’ companies have been consistently the most prominent sector in the four Connect investment conferences, although e-commerce (other category) reveals dramatic growth between the 1999 and 2000 conferences. This reflects the high level of dot-com start-up activity in 2000. Biotechnology has also had a consistent presence in the 1999 and 2000 conferences.

Graph 8.26 shows the type of investment funding sought after by the companies presenting at the investment conference. These are *SEED funding*, *early commercialisation*, *growth funding* and *public funding*. Over the years the relative demand for each of these types of funding exhibit a highly variable pattern. In 1997, for instance early-commercialisation funding was by far the most sought after type of funding.

In 1998, the funding preference moved to SEED funding with commercialisation closely behind in second place. In 1999, SEED funding was clearly at the top with early-commercialisation being displaced by growth funding in the second place. Finally, in year 2000, growth and SEED funding shared the place with the top demand. It is also interesting to note that public funding was sought after only in the first conference, with public funding not evident since.

Graph 8.26: Investment Expectations for Attending Investment Conference Companies, 1997-2001

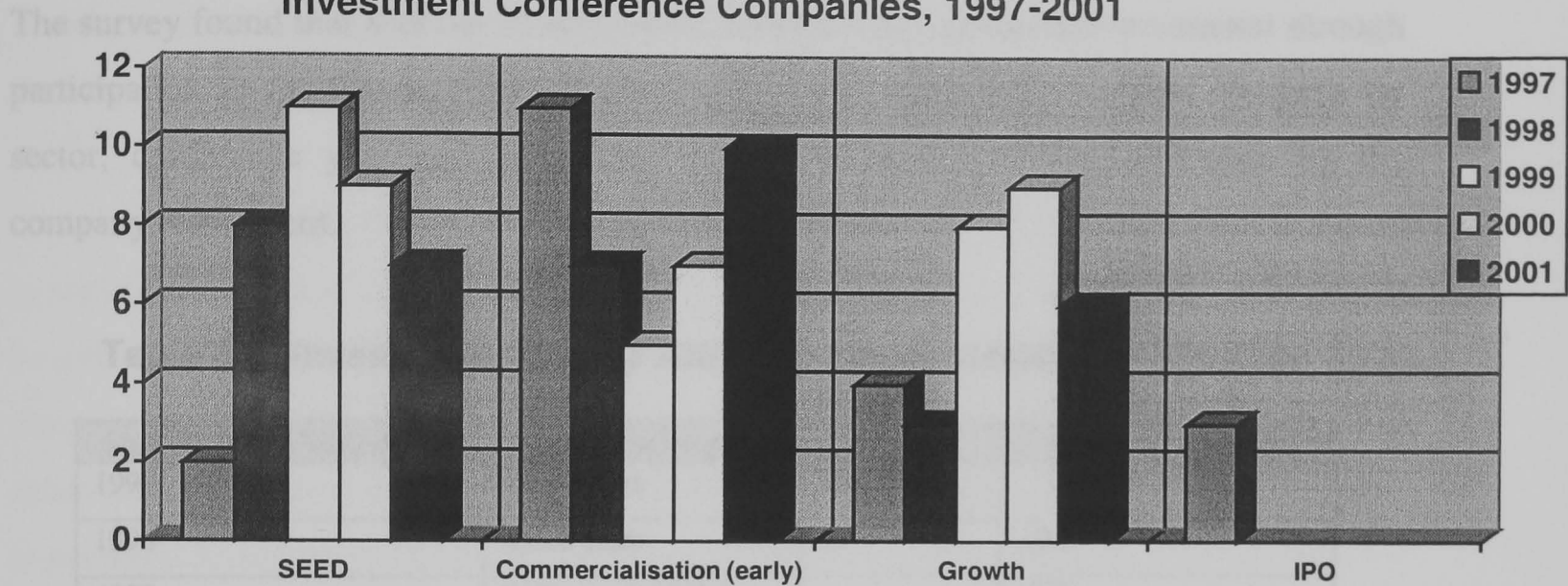


Table 8.8 distinguishes between the types of investment funds sought.

Table 8.8: Types of Investment Funds Sought by Presenting Companies at Investment Conference²⁰

SEED	First (initial) phase of funding: to verify technology/product with prototype, protect the technology with patents, cover professional fees, complete market analysis and build credible initial management team. Typically £25,000 to £250,000 sought.
Commercialisation & Development	Second or third round of funding to cover costs associated with physical location, taking product to market and market entry. Broad range depending on the technology and sector; £100,000 to £1-3m
Growth	Subsequent stage of funding to cover costs associated with growing demand: more human resources, sales and marketing, increased product capacity. Funds required depend on current success, technology and sector.
Public	Initial public offering (IPO): funds to be raised from an offering of common stock (equity) of the company to the public. Usually more that £3 million.

²⁰ Definitions from Bank of England reports “Finance for Small Firms, April 2002 and “University Spin-outs, August 2001.

Literature suggests there is no one commonly accepted definition for stages of funding; instead they are normally secured in sequential fashion following the success of achieving certain milestones. Milestones include proof-of-concept, letters of intent to purchase the technology, establishing the management team, actual sales, level of growth, etc.

8.4.4.2 Investment Survey Results

The survey found that 8 of the 35 companies surveyed directly gained investment through participation in the Connect Investment Conference. Table 8.9 identifies company by sector, conference year and investment amount attributed to the conference by the company respondent.

Table 8.9: Investment *Directly Attributed* to Investment Conference

Investment Conference	Company Sector	£	% of Investment
1998	Electronics	365,000	
1998	Electronics		10%
1999	Telecom (mobile)		25%
1999	Software		50%
2000	Medical/health	100,000	
2000	Opto-electronics		100%
2001	Software	2.5 million	
2001	Medical		80%

A further two companies confirmed *indirect* attribution of investment gains to Connect’s Investment Conference:

- ❑ 1998: Software: £850,000
- ❑ 1999: Biotechnology: £1.5 million

The bio-technology respondent comments that the significance of the Investment Conference for their company “*was to start the ball rolling and to build on momentum from there.*” He adds: “*the VC community does tend to act locally and it was critical for us to keep [VC firm] and Scottish Enterprise on side. The other two VC funds at the*

investment conference who invested in us really came on the back of the original two investments and their follow-through”.

The survey also found that a further 17 of 35 respondents attributed non-investment benefits from their participation at the Investment Conference. The conference is identified as a valuable forum for fine-tuning business propositions for subsequent funding. A respondent from the 1999 Conference states, *“the process was an invaluable pre-cursor to the first-round funding we finally secured”*, while a respondent from 2000 comments: *“our company indirectly gained benefits by helping close and gaining more control over a deal that we already had in place”*.

One respondent from 2000 identifies the conference as a training forum for their company in stating: *“No direct investment came out of the presentation. It was a little too early to be asking for £1 million as the company was still quite embryonic. We did learn the sort of things needed to move the company forward though and today we are much more substantial.”* Another respondent from 2000 asserts that *“we benefited from the exposure to potential investors and it did focus our attention more on the planning of the business”*.

Profile raising and public relations is another identified benefit derived from presenting at the conference. A respondent in 2000 states: *“Presentation at the Conference was a key element in raising finance (and profile) of the company. Though the deal is yet to be closed, the conference was instrumental in making connections with 2 syndicate members. Similarly, a respondent from 2001 states: “We did get benefits in terms of exposure to the VC community and assistance in refining our sales pitch. But we didn’t get investment from the conference.”*

Findings identify the difficulty in attributing a direct role of Connect in gaining investment. One respondent from 1999, states: *“We have received in excess of £1 million of funding since the Connect conference, but none of it was as a direct result. The indirect amount is more difficult as the public relations (PR) cannot be quantified.”* Similarly, another respondent comments: *“The value of the networking opportunities and the lifting of our*

profile are incalculable, as we enjoyed and learned from the experience of presenting at the conference”.

The 7 respondents who attributed no benefits to their participation in the Investment Conference forwarded no negative comments of the Investment Conference. One respondent did suggest that the conference was not the most appropriate for their needs. He states: *“our belief was that it was not the right type of forum for a company such as us, which has been established for 10 years, but has remained small and is now looking for a small amount of mezzanine funding. The attraction of Connect was the limited time we had to put into the fund raising to gain access to a group of investors.”*

According to Dr. Andrew McNair who is responsible for the investment events, a noticeable shift in attitudes from those involved with the Investment Conference occurred between 1998 and 1999. Andrew states that presenting companies were suddenly a lot more bullish, and the 1999 Investment Conference attracted more interest from venture capitalists (VCs) not only from around Scotland but also from London, Europe and a few from the United States. Andrew calls the 1999 event “a real milestone” as 43 qualified applications were received for a total of 24 presenting companies, 4 more than in 1998.

8.4.4.3 ‘Springboard’ Results

Connect has run two Springboard events in 2000 and 2001 for 13 companies and seen an increase in audience attendance from 100 to 140. Audience attendees include large corporations and venture capital firms that include Cisco Systems, BP, 3Com, Scientific Generics and 3i, among others.

It has been more difficult to measure attribution of benefits and determine the success of Springboard in comparison to the Investment Conference for the following reasons:

- ❑ Springboard provides a forum of support by Connect to companies to get them ‘investor-ready’, and to expose them to a more ‘friendly’ audience that is supportive. Investment is thus not the primary goal.
- ❑ Springboard is a complement to the Investment Conference and thus the impact of investment will be more apparent and expected at the Investment Conference
- ❑ It can only be inferred that companies are more successful at the Investment Conference (or elsewhere) in securing the funding they seek because of their experience at Springboard. With only 2 years of Springboard, this is yet to be determined.

8.5 DISCUSSION AND SUMMARY²¹

Findings show Connect to be an increasingly stable social network based on a consistent affirmative response level of stakeholders identifying the network as a forum for meeting interesting people and feeling part of a social group. The network is facilitating more social capital overall with a notable increase in more demanding social value indicators.

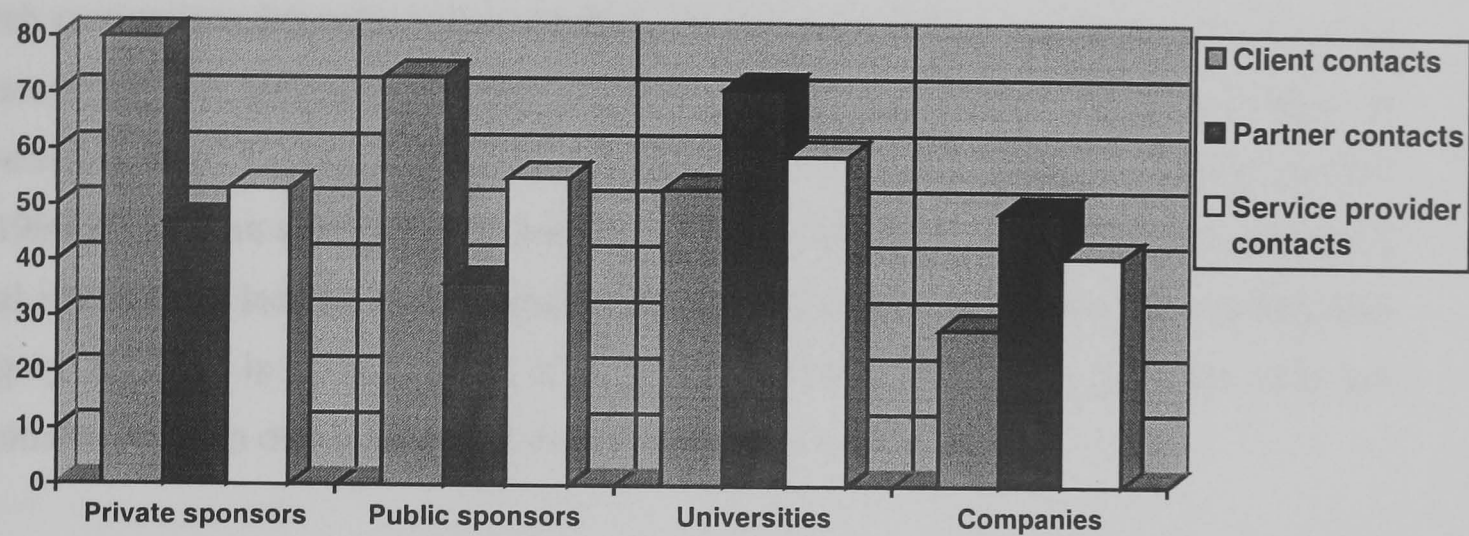
A key finding in this chapter is the evolution of perceived network value. Value flows within the Connect network have evolved towards more business-focused benefits represented by knowledge and financial indicators in the survey. This evolution of social to business exchange is consistent with research suggesting a logical evolution of networks where social interactions and acquaintances tend to precede exchanges and collaborations involving resources (Larson and Starr 1993).

Findings show the Connect network is facilitating institutional linkages and stimulating collaboration that remains a central element of Connect’s mission statement. Graph 8.27 shows that for sponsors and universities, potential collaborators are not only in attendance at network events but that social interactions are occurring between and among clients, service providers and partners. As would be expected, ‘client contacts’ are rated highest

²¹ Chapter Eleven continues the network evaluation as Connect evolves to a private company. Therefore, conclusions identified here are only based on network evaluation undertaken in this chapter, with Connect operating as a public-private organisation.

by public and private sponsors, while ‘partner contacts ’ and ‘service provider contacts’ are rated highest by universities and technology companies.

Graph 8.27: Social Exchange among Institutions: Meeting Potential Clients, Partners and Service Providers at Recurrent Events (n=116)



Differences in stakeholder perceptions of network social value can be traced to search expectations that motivate network attendance and benefit accumulation that shows an eventual diminishing return. The latter explanation is particularly relevant for technology companies where social capital is used to establish business relations and access knowledge and financial value. Indeed, as Table 8.10 shows, there is significant correlation between social and financial indicators from the value survey²².

Table 8.10: Correlation Between Social and Financial Value Indicators from Recurrent Events (n=116)

Variable 1	Variable 2	Correlation (Pearson's PM)	Significance Level
(Social) Made good contacts with investors	(Financial) Obtained investment for my business	.546	.01
(Social) Met potential backers of my idea/product	(Financial) Obtained investment for my business	.497	.01
(Social) Introduced my technology to a highly relevant audience	(Financial) Obtained investment for my business	.450	.01
(Social) Made good contacts with entrepreneurs	(Financial) Invested in a new technology or business	.366	.01

²² SPSS correlation analysis provides evidence of relationships between variables in the value survey. Pearson's Product Moment Correlation Coefficient (r) is used to measure interval variables (Bryman and Cramer 1994) showing *significant correlation* in the exchange of social, knowledge and financial value using both surveys as a single sample. However, causal relationships cannot be inferred from correlation alone (Childs 1990) as some test scores are the end products of processes – such as thinking or perceiving. Thus, these scores are considered in the context of other evidence deriving from stakeholder feedback.

Table 8.10 suggests that development of positive social relations is important for both investors and those being invested in. Another social factor identified in stakeholder feedback is the importance of introductions by third parties that initiate contacts with investors at recurrent events and also introduce investors to new business prospects.

Search motivations for universities, on the other hand, have been identified with securing investors for the technologies they represent. One explanation for the increase in university perceptions of social value in 2001 is that low levels of financial value, seen in the 1999 survey, are stimulating technology transfer personnel to more actively engage in social interactions leading to investment. As for individuals and others, this stakeholder category in 2001 is comprised of a significant number of private investors who are potentially active in developing new social contacts as well.

Connect's value as a knowledge network for all stakeholders is most importantly in its provision of relevant business commercialisation knowledge and knowledge on technologies. All commercial-related knowledge indicators have increased in 2001, and this increase is primarily from sponsor and university respondents. A significant increase in perceived knowledge value is much more extensive among sponsors and universities than expected. Indeed, the expectation was that technology transfer personnel at universities and private sector service providers would already possess a high level of commercial knowledge compared to entrepreneurs and new companies.

Private sponsors identify their 'use' of recurrent events as an informal educational forum particularly for new staff or those seeking a greater awareness of local technologies and service provision to particular technology sectors. This knowledge includes many issues not traditionally offered within the legal and accounting communities, such as business planning, structuring a financial deal, protecting or licensing a technology. Keeping abreast of the latest in technology due diligence interacting with all Scottish universities and associated research institutions also provides management consulting companies with a forum for their technology-specialists. The identified lack of new client deal flow attributed to recurrent events by sponsors reinforces the importance of knowledge provision to sponsors.

Another key finding is the significant increase in perceptions of the Connect network as a facilitator of financial value. Identified was an evolving level of exchange between entrepreneurs, investors and others and the provision and receiving of valuable financial information that are explicit components of financial value indicators. Also identified was a notable increase to the question “have obtained investment”. Returning to earlier findings, correlation between social and financial indicators suggests that high levels of social value identified in 1999 have evolved into business relationships and investment.

Sponsors and the individual/others stakeholder category outperform both university and companies regarding perceived financial value. As noted earlier, sponsors are particularly interested in learning about the financial risks of technology. A number of individual members are identified as private investors and it is suggested that business angels are playing a stronger role in the network in 2001 than in 1999. Certainly the individual/other stakeholder category are much more actively involved in the network overall with significant increases in social, knowledge and financial value perceptions.

The drop in university perceptions of financial value from 1999 to 2001 is traced to a combination of factors. One is the identified concern that universities, despite indicating higher perceptions of social value in 2001, are not as involved in reciprocal value exchange and are primarily seeking investors for their technologies. Another factor, identified in stakeholder comments, is that many universities are difficult to deal with, e.g. over-valuing their technologies or seeking unrealistic partnership terms. Findings identify a higher number of private investors attending Connect events, and these investors may be more attracted to technology opportunities outside university control.

These findings suggest that greater effort is required to improve the university-industry interactions within the network and ensure a proper mix of stakeholders. University participants comprise 16% of attendees compared to the target of 30%. The attendance patterns of technology briefings suggest that there is much to be done to stimulate closer relations and interactions between university and business. The objective of technology briefings is to provide a forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies.

Another observation is the progressive drop in sponsor attendance from 1997 to 2000. Connect cannot assume that sponsors' numbers will simply rise again when economic conditions in the services improve. Other support initiatives such as First Tuesday or the high profile 'Entrepreneurial Exchange' provide sponsors with various choices and stakeholders identify that they cannot afford to be members of multiple support programs.

Connect's three investment events, *Investment Conference*, *Springboard* and *Bootcamp* demonstrate a mentoring role by Connect in linking a cross-section of Scottish technology sectors (e.g. bio-technology, medical, industrial, electronics, software, others) with investors. The Investment survey reveals significant *tangible benefits* gained by presenting companies: directly attributed investment by 23% of respondents and a further two companies identified £2.35 million indirectly attributing it to the Conference. Approximately 80% of respondents attributed various *non-investment benefits*, including fine-tuning the business proposition for subsequent funding, meeting potential investors, profile raising and public relations, among others.

Survey results confirm the growing challenge of Connect to remain relevant to a cross-section of regional technology sectors. Overall, the 2001 survey identified an increase in stakeholder complaints and concerns regarding Connect's relevance to a multi-sectoral technology audience that was not identified in the 1999 survey. This increased level of critical feedback requires an ongoing vigilance and level of monitoring on Connect's part and verifies the importance of a real-time evaluation approach. Identifying changes in attendance, membership and stakeholder mix patterns and addressing ongoing concerns among stakeholders as they arise allows for a proactive rather than reactive philosophy for effective network management, and a departure from normal intervention program methods.

CHAPTER NINE
CASE COMPANY ANALYSIS

9.1 INTRODUCTION

The constituency-building approach for evaluating Connect now focuses on the real experiences of six technology company members of the network, their origins, principal reasons for their success and challenges they have faced in their development¹. Following a brief description of each company and their experience with Connect, case studies are synthesised and analysed from an entrepreneurial process point of view. Common themes and challenges to early stage company development in the Scottish context are discussed along with recommendations from companies to improve the support environment in Scotland.

9.2 DESCRIPTION OF CASES

Each company’s founder(s) were interviewed as well as other senior managers to present as accurate a picture of the early development of these case companies as possible. Each of the six companies was established during the 1990s, Spektra Ltd. being the oldest with its roots established in 1990, and Intrallect Ltd. being the youngest firm, having spun out of Edinburgh University as recently as 1999. Cases and their commercial sectors were as follows:

- | | |
|-----------------------------|------------------------------------|
| ❑ Spektra Systems Ltd. | Computer Software |
| ❑ Yaba Ltd. | Biotechnology; Testing Kits |
| ❑ AXEON Ltd. | Microprocessor-based Electronics |
| ❑ Intrallect Ltd. | Data Storage |
| ❑ DILAB Ltd | Diamond Coating - Materials |
| ❑ ExpressOn Biosystems Ltd. | Specialised molecular technologies |

¹ Complete cases have not been included in the appendices due to their combined length but are available on request.

9.2.1 Spektra Systems Ltd²

9.2.1.1 Company Description

Spektra Systems, based in Livingston, is one of Scotland's most successful and high profile software companies. The company was founded by Managing Director Gordon Stuart in 1990 as Schindler R+D, a software research and development facility for the world's largest manufacturer of elevators, Schindler AG of Switzerland. The present form of Spektra was the result of a Management Buy Out (MBO) in 1996. Russell Brodie, Development Director and Euan Robertson, Technical Sales Director are the other owner/managers of Spektra.

Although a five-year contract signed with Schindler initially provided Spektra the opportunity to focus on target markets and refine best practice, Spektra now provides internet-based business applications for large corporate clients such as Scottish Widows, Scottish Equitable, and The Royal Bank of Scotland. Spektra specialises in the core plumbing that sits behind many dot.com and business-to business e-commerce systems of today and has developed a high level of technical knowledge for complex and demanding software development and consultancy work. As well, Spektra advises blue-chip clients in the development of strategies for one-to-one Internet trading and web marketing. Spektra is the only Sun Microsystems Authorised Java Centre in Scotland, and are a business partner for IBM Lotus.

9.2.1.2 Experience with Connect and Other Support Initiatives

As an original company member of Connect since 1996, Spektra has realised an array of primarily intangible benefits through its participation at Connect events. The three Spektra directors interviewed all noted different reasons for attending Connect, although they were all seeking primarily *intangible* benefits.

² Case information is derived from interviews with Spektra's three directors: Gordon Stuart, Managing Director, Russell Brodie, Development Director and Euan Robertson, Technical Sales Director.

Technical Director Euan Robertson points out that Connect was very much from Spektra's viewpoint the most appropriate support program back in 1996. He states: *"Connect had the right players in it; had the like-mindedness and was buoyant and positive with a we can do it attitude. Connect speakers were entrepreneurs who had been there and done it, and events were focused"*.

Euan sees the networking through events as the key attraction of Connect. Euan says this relates to the fact that the first thing a company does is go to the lawyer to write up legal contracts to protect assets IPR, then asks the lawyers, *"who should I be talking to"*. From this point begins the process for the company of building a reputation through contacts with others. He states that there is a focus there with Connect that provides for the opportunity to do deals. He notes that Connect has identified the people that have been there and done it, and Connect has got them involved.

One important feature of Connect, Euan points out, is the critical mass of people that begin to talk about you. He states: *"...so that when someone says have you heard of Spektra, there is this mass of the right people who know you. This facilitates lots of cross-fertilisation that goes on through Connect"*. Euan's comments on the importance of getting known relate to stakeholder findings on the importance of getting to know the right people at Connect events.

Spektra's Development Director Russell Brodie views the value that Connect provides from two levels; one level is what he calls the *"Gordon and Euan level, where you want to network at an event when Spektra happens to be looking for venture capital investment"*. He states that Connect can act as a channel to find the right investment people and obtain the right kinds of advice and recommendations.

Through Connect, Spektra has met people that have provided financial and technology information and advice. At the Investment Conference in 1998, they met an executive from Motorola in Germany, and visited him in Germany. As Managing Director Gordon Stuart comments, this visit encouraged Spektra to *"think out of the*

box” and take a more international focus to its business. A number of the dot.com opportunities for Spektra have come through the relationships that were either made directly through Connect or indirectly.

The second level of value is in providing a network to access good people. In his role as Development Director, Russell suggests that Connect is a valuable forum for overcoming what he argues is a significant barrier to growing a software company in Scotland – finding and recruiting people.

Russell notes that overall Connect has been appropriate for Spektra’s senior people, but not for the technology-focused staff, as these staff want to find out about what is new in technology nitty-gritty details. He suggests that many Connect events would be more of a passing interest to these people.

9.2.1.3 Summary of Most Positive Effects of Connect

- ◆ *“Spektra has only been seeking intangibles from the Connect events and that is what we have received”*
- ◆ *“Connect is a very good organisation; particularly valuable in the learning phase”*
- ◆ Connect is focused where it should be
- ◆ Connect needs to recognise that its member constituents will change, although sponsors and investors will stay basically the same
- ◆ Connect’s Investment Conference is good and should be held every 6 months instead of annually. This is because of the frequency of start-ups and it gives a reason for foreign investors to come to Scotland

9.2.2 Yaba Ltd³

9.2.2.1 Company Description

Yaba was created in 1997 as a 'spin-out' from the Moredun Research Institute located at Pentlands Science Park in Penicuik. Dr. Gareth Jones, considered to be one of the world's leading veterinary chlamydiologists founded Yaba to develop and produce state-of-the-art diagnostic kits for both human and veterinary medical markets. Yaba's mission involves two objectives: to develop novel, highly specific diagnostic tests for the infectious disease market (humans and animals); and to increase shareholder value through innovative technology development.

9.2.2.2 Experience with Connect and Other Support Initiatives

Yaba joined Connect in 1997. Scott states that they were very fortunate coming at it when they did, as Connect was in its infancy and people were beginning to buy into the Connect concept. In particular, he points out the speakers as top of the range.

Scott identifies the diversity of information and knowledge at Connect events. He states: *"the information and advice is invaluable because there is no angle to it; there is often frank and candid advice given based on others' experiences. i.e. not all venture capitalists are the same"*.

Scott notes that *"Connect is a place where you can get the buzz on the streets and find out for example who's got money and doesn't have money"*, you can also get a better understanding of business angels and where they are coming from. You don't have to go through a whole learning curve on certain issues, you can do that through Connect.

³ Case information is derived from interviews with Yaba's two directors; Dr. Gareth Jones, Technical Director and Scott Johnstone, Marketing Director.

As Scott states, “*without Connect it would have been difficult for Yaba to know the strengths and weaknesses of all the commercial bodies; what’s the difference between the professional service providers?*” This information allows for comparisons.

Although the small size of Scotland is sometimes cited as a limitation, Yaba has pointed out lack of knowledge on the part of the investor community on biotechnology. Both Gareth and Scott see a more active role for Connect in this regard. Scott states that “*Connect is about getting people together to make it more difficult for the ones that normally say no, such as venture capitalists, angels, and high flying CEOs*”.

Both Gareth and Scott identify the importance of the 1998 Connect Investment Conference in generating investor interest in Yaba and allowing the company to focus more on their opportunity. However, they concede that investor interest fell away, reflecting the nature of biotechnology at the time that was entering a sectoral downturn. Gareth states that if he had to do it all again, he would chose to go to one investment conference in Scotland and one in London; or somewhere more international. One of the companies Yaba is talking to for second round financing is London-based and Gareth suggests that it is unlikely that they would be attending future investment events in Scotland, stating “*we have exposed ourselves to any serious biotechnology investor in Scotland by now*”.

Scott feels that much of the positive effect of Connect results from its informal network focus. Through Connect, company profiles can be raised in the hope that other companies coming through will have an easier time than Yaba. Scott doesn’t think there will ever be an “easier time”, but companies will also benefit from knowing what companies before them have gone through.

Scott suggests that Connect events may be getting somewhat diluted, as people are being spread around more thinly in terms of the number of presentations.

9.2.2.3 Summary of Most Positive Effects of Connect

- ◆ *“Connect has been our single most helpful support organisation”*
- ◆ Yaba’s lawyer was met through Connect
- ◆ Yaba’s company mentor (non-executive director) was found through Connect
- ◆ Yaba is engaging in second-stage investment through a Connect contact
- ◆ Connect reflects a shared vision of everyone of future success of start-ups
- ◆ Relevant event topics are available according to industry sector
- ◆ Meeting different people that share similar experiences (lonely as an entrepreneur)
- ◆ Connect provides an alternative to technology-focused programs such as Scottish Enterprise Clusters Team, Edinburgh Biotechnology; these forums allow one to sit around with competitors in sector-specific discussions

9.2.3 AXEON Ltd⁴

9.2.3.1 Company Description

AXEON was formed in 1998 by Hamish Grant and his wife, Susan in Aberdeen to leverage their knowledge and experience gained in building and selling SYSTEMS FX, a UK based software testing tools and services business. AXEON’s creation is based on an Umbrella Agreement with the University of Aberdeen to develop the Learning Processor™, a unique patent protected architecture targeted specifically at providing cost and power efficient solutions for non-linear system problems.

The Learning Processor™ has been taken from the conceptual design stage to a fabricated prototype and it is now part of a process to launch several new product ranges. AXEON now works with alliance partners in developing application specific solutions, hardware development kits and training/developer support programmes.

⁴ Case information is derived from two interviews with AXEON owner Hamish Grant.

AXEON also provides a range of other additional processor products such as accelerator cards, chip sets, simulation tools and network management systems.

9.2.3.2 Experience with Connect and Other Support Initiatives

AXEON has been a member of Connect since 1998 and Hamish suggests that Connect is a highly appropriate support group for firms at the initial stages of developing technologies and looking for funders: *“We used Connect and Ian for all our various funding rounds. They introduced us to the Sutherland guys who were half of our first funding round. They also took us to the Hamilton guys for later rounds”*.

Hamish identifies Connect CEO Ian McDonald, in particular, as a strong supporter of AXEON's efforts. He states: *“We presented at both the '98 and '99 Connect Investment Conferences. Those conferences gave us a platform on which to advise ourselves. The meetings proved to be a very good networking environment and indeed Ian McDonald himself was a very good person who had a good source of contacts. I rung him up several times and said ‘Ian I'm in a hole. Do you know someone who can do x, y, or z’?”*

As well as providing a crucial link to potential investors, Connect is seen by AXEON providing a local meeting place and networking opportunities. Hamish comments: *“Even if you think that you have a very strong market expertise and technical expertise, there are always bits of the picture that you don't know, be it a corporate finance guy or sales person. Being able to call someone up or meet someone and say ‘point me in the right direction’, the social things, is one of the things I really appreciate most about Connect”*.

Hamish suggests that unlike some other support groups, Connect does not attempt to say *‘we are going to come in and somehow make you a better business’*. The ethos

of Connect is viewed more in terms of “*we will give you a platform and a bit of guidance along the way that will help you show off your wares*”.

9.2.3.3 Summary of Most Positive Effects of Connect

- ◆ Investment events and forum to meet potential investors
- ◆ Increasing network opportunities with potential partners and collaborators

9.2.4 Intrallect Ltd⁵

9.2.4.1 Company Description

Intrallect is a Livingston-based company formed in June 2000 by Dr Charles Duncan, Dr Peter Douglas and Dr Martin Morrey as a spin-out from the University of Edinburgh. The company offers software ("middleware") tools for the current and next generation of e-Learning systems. Intrallect's mission states: “*Intrallect will dominate the provision of content management systems for e-Learning systems to the larger corporate organisations of the world by offering high-quality, platform-independent tools... "Superior products at competitive prices delivering unique e-Learning tools"*.

Intrallect also offers turnkey tools and content for specialised areas, air-traffic control, meteorology, etc. that provide entry into the high-value, academic and quasi-government contracts offered by various European countries. Intrallect also hosts and organises international conferences and seminars, the most recent being in Sao Paulo, Brazil, harnessing the reputation of Dr. Charles Duncan, CEO.

⁵ Case information is derived from interviews with two of Intrallect's founding directors; Dr. Martin Morrey and Dr. Peter Douglas.

9.2.4.2 Experience with Connect and Other Support Initiatives

Intrallect has been a member of Connect since 1998. Martin has found Connect to be highly valuable in the early stages of company formation. For example, Connect helped Intrallect's application for a SMART award and provided hands-on assistance by introducing Intrallect to various people in the Connect network. Both Martin and Peter identify the value of speaking with entrepreneurs that are experiencing similar '*trials and tribulations*' of growing a company that provides a key reason for attending Connect events.

Peter and Martin also credit other support agencies that provided assistance to Intrallect. In winning the '*who wants to be an entrepreneur*' award, Intrallect has received strong support from Scottish Enterprise's local enterprise company (LEC) in Lanarkshire, and in particular one consultant – Campbell Murray, who assisted Intrallect in entering the network because of his enthusiasm for their technology and business. Martin asserts that the combination of Research Fellowship, SMART, QUEST award, '*who wants to be an entrepreneur*' have been essential to their success to date. The early support from Edinburgh Technology Fund and its Director, Keith Winton, is also identified as a key factor.

Martin suggests that advisors providing commercialisation support must have practical knowledge if they are to be credible and helpful to new companies. Martin states that Connect's credibility is in providing a certain level of advice then introducing you to another level of advice through others in the network. Peter suggests that the evolving and accumulating knowledge of entrepreneurs also require varying types of advice and support that will also change over time.

9.2.4.3 Summary of Most Positive Effects of Connect

- ◆ Business skills and knowledge
- ◆ Advice on company formation and spinning out of the university
- ◆ Guidance on applications for seed funding
- ◆ Friendly and supportive environment of like-minded people

9.2.5 DILAB Ltd⁶

9.2.5.1 Company Description

DILAB began in 1994 at Heriot-Watt University as collaboration between Professors Philip John in the Chemistry department and John Wilson in Physics that was based on a shared interest in materials problems. DILAB provides diamond films and coatings for mechanical, optical, electrical and other engineering industries using a decomposition process that produces chemical vapours in an electrical discharge.

Although DILAB is an incorporated company, a unique characteristic is that it remains within the university through a ‘symbiotic’ agreement with the university. The strategy of DILAB is to remain at the university providing contract solutions for specific commercial clients until such a time that major commercial opportunities allow it to spin-out. Philip and John, and a third unnamed original founder all retain their academic positions with Heriot-Watt University. A fourth owner, the only non-academic, provides the role as Financial Controller for DILAB.

9.2.5.2 Experience with Connect and Other Support Initiatives

DILAB has been a member of Connect since 1997, one of the oldest standing members in the network. John states that they met their lawyer at Connect meetings.

⁶ Case information is derived from an interview with DILAB founder Professor John Wilson.

But John suggests a primary reason for his ongoing involvement is to network with others going through similar commercialisation difficulties and growth. They continue to nurture connections that may lead to potential partnerships with DILAB. Time constraints have limited his involvement in Connect more recently.

John suggests that Scottish Enterprise events have been beneficial in providing good advice on strategy, and he cites a previous program put on by Edinburgh Council focused on assisting defence companies to diversify, focusing on marketing, sales and publicity. Being encouraged that a company was possible, John and Philip were chosen to attend a European course sponsored by Scottish Enterprise along with four other Scottish companies that provided three separate weeks of course work.

John states that Scotland has been a supportive environment overall with a level of encouragement and a level of competition between universities comparing their commercial output. However, he finds that investment is still tight.

In terms of academic entrepreneurship in Scotland, John suggests that with changes to academic life, e.g. less freedom to pursue research interests, more academics may pursue commercial opportunities. John suggests that initiatives to promote entrepreneurship at UK universities will be beneficial to those students that have an interest, but he asserts “*that it is difficult to ‘make’ entrepreneurs*”. John further suggests that it is important to demonstrate to students what is possible and provide the message that *‘entrepreneurship is not so much of a black art’* but John concedes it is difficult to know how much impact these efforts will make on economic life in Scotland.

9.2.5.3 Summary of Most Positive Effects of Connect

- ◆ DILAB met lawyer through Connect
- ◆ Broad base of business skills and advice highly relevant to the academic partners

- ◆ Continue to meet potential partners or collaborators although nothing has transpired to date
- ◆ Good contacts with other academic entrepreneurs sharing similar experiences

9.2.6 ExpressOn Biosystems Ltd⁷

9.2.6.1 Company Description

ExpressOn BioSystems Ltd was founded in 1999 by Dr. Peter Estibeiro and Dr. Eleanor Barnard to provide access to specialised molecular technologies and to develop a range of effective antisense reagents. Prior to starting the company, Eleanor worked as Peter's postdoctoral student on neuro-degenerative diseases in the Department of Biomedical Science at Edinburgh University. The location of the company, at the Roslin Institute near Edinburgh, is identified by Eleanor as an advantage particularly due to the support they receive in areas such as health and safety and waste disposal and the international reputation of Roslin that bodes well as an address for the company.

ExpressOn Biosystems provides an integrated package of consultancy, experimental services and proprietary technology that supports bioscience research for pharmaceutical, medical and health outcomes and clients. It is currently the only antisense design company in Scotland, specialising in the rapid design of effective antisense reagents, and is focused on developing antisense as therapeutics for the treatment of neurological disorders. *Antisense* reagents are a relatively new class of drugs, but they have the potential to provide greater therapeutic benefit than traditional drugs. ExpressOn aims to unlock that potential through the rapid design of effective antisense reagents guided by its mission: *"To further scientific research and drug development through the provision of high quality, technologically advanced products and services to those at the cutting edge of bio-science"*.

⁷ Case information is derived from interviews with Dr. Peter Estibeiro and Dr. Eleanor Barnard.

9.2.6.2 Experience with Connect and Other Support Initiatives

ExpressOn joined Connect in 2000 and Peter suggests that Connect has been '*immensely valuable and instrumental*' in providing credibility for ExpressOn. The Connect Investment Conference provided positive exposure to the VC community and press coverage that attracted Adam Christie, their commercialisation director to the company. Peter also found their current venture capitalists through the investment conference, and as a direct result of going to Connect, ExpressOn is closing its second round of funding. Peter has also presented for Connect at one of its events. ExpressOn is planning on applying to present at the next investment conference to secure its third round of funding.

Eleanor states that Connect provided a great deal of benefit early on but the company has moved on. Business advice changes as the needs of the company change and ExpressOn now receives more specific business advice from their board members and venture capital investors.

In terms of other support mechanisms, Eleanor states that Scottish Enterprise, in particular Rhona Ellison, has been particularly helpful for the company in providing portions of funding support – 50% cost -funding support for market research for the business plan, 20% for the JANET computer network, and 50% for additional market information.

More than anything, Scottish Enterprise has enabled ExpressOn to close the latest round of investment by providing £150,000 in equity following a financial and market due diligence assessment by Grant Thornton that found that ExpressOn was suffering from market failure. In other words, the funding gap experienced by ExpressOn was seen as a lack of investment funds available rather than a deficiency in the investment opportunity. This shortfall of £150,000, had it not been filled by Scottish Enterprise, would have resulted in the company ceasing trading according to Eleanor.

9.2.6.3 Summary of Most Positive Effects of Connect

- ◆ ExpressOn attracted their commercialisation director through Connect
- ◆ Exposure and credibility through Investment Conference and met second round investors through Connect
- ◆ Valuable business knowledge and information

9.2.7 Section Summary

In this section, companies have described their experiences with Connect and other support programs without examining the basis for support or understanding the factors contributing to the success of these companies. In other words, absent is an understanding of creation and formation processes and challenges as perceived by those people involved.

The next section takes an analytical approach to examining the entrepreneurial processes, commercialisation challenges and strategies of these case companies to qualify the effects of Connect and other support programs.

9.3

SYNTHESIS OF CASE STUDIES FROM AN ENTREPRENEURIAL PROCESS PERSPECTIVE

This section synthesises case results that establish how original technological innovations have been exploited and companies formed, the ongoing challenges to growth and regional enablers and constraints from the viewpoint of company founders and directors. These factors will be examined under four common themes identified in the case analysis – pre-formation, formation, growth and opinions on external support.

9.3.1

Pre-Formation

9.3.1.1

Core Technologies and First-Mover Advantage

For each of the six case companies, a core technology has provided a major technological platform upon which the company was based and from which further product ranges are supported. For all cases but Spektra, company-forming technologies can be directly traced back to research programs conducted within Scottish universities or research institutes. Spektra’s origins however are based on spinning out of a corporate parent and modifying previous technologies gained as an R&D unit. Core technologies are as follows:

- | | |
|----------------------------|---------------------------------------|
| ◆ Spektra Systems Ltd | Customised e-commerce software |
| ◆ Yaba Ltd | <i>Panclabort</i> , chlamydia testing |
| ◆ AXEON Ltd | Learning Processor™ |
| ◆ Intrallect Ltd | E-Learning Middleware |
| ◆ DILAB Ltd | Diamond-coating |
| ◆ ExpressOn Biosystems Ltd | Antisense Agents |

The majority of these companies sought to exploit 'first mover advantage', whilst also expressing a clear awareness that such strategic positions were often only temporary. Differences can be seen in how each adapted their core technology largely dependent

upon the nature of their core-technology and the market sectors each company chose to compete in.

For example, Yaba's technology, *Panclabort*, established a first-mover advantage in testing for chlamydia by providing a complete test system unlike existing tests at the time that required an initial reference procedure before administering the test. Panclabort requires no special training and thus is easier to use than current tests on the market. Yaba has adapted Panclabort from a veterinary application to encompass diagnostic kits for both human and veterinary medical markets. This adaptation of the core technology to many other market segments relatively quickly came after a certain level of knowledge, skills and experience had been gained during the process of developing the technology for the initial target market.

In the case of ExpressOn, the first-mover advantage occurred through research in a relatively recent technology that allowed the company to become the only antisense company in Scotland and one of only a few in Europe with the ability to develop antisense. The company mission explicitly states how its core technology is to be developed in providing the first of a new generation of antisense-based applications and in becoming a major player in pharmaceutical and molecular technology customisation through the adoption of their platform technology. The company's emerging market strategy is based on its prediction that antisense therapeutics will become the most significant medical advance since antibiotics.

Indeed, the potential of adapting ExpressOn's technology is based on the breadth of applications and global market reach for their science as well as for the related services they provide to potential customers. The service offering - an important component of ExpressOn's strategy - is explicit in its focus to provide value for money and service flexibility for clients looking for various antisense applications. The importance of the company's service business to complement its science can be seen in the variety of qualifications that ExpressOn continues to secure. They include Quality Assurance (QA) procedures based on six principles defined by the DTI-sponsored National Measurement System Valid Analytical Measurement

(VAM) Programme, Good Laboratory Practice (GLP) standards and ISO 9001 accreditation.

Intrallect's strategy of being 'first to market' is based on its range of e-learning tools developed from its award-winning EuroMET technology. Co-founder Peter Douglas states that Intrallect's strategy began with an assertion that the company did not have any competitors and had a unique product. He adds that there were no obvious direct competitors at the time, but similar companies were evident in hindsight that were seeking funds to enter the same market with related products.

The distinctive advantage of Intrallect's tools for the e-learning market, according to Peter, is that they are designed to be rigorously compliant with existing standards/specifications, now and in the future. This compatibility feature combines with constantly improving innovations to the original EuroMET technology in providing transformation channels to delivery content from a single source into multiple delivery channels. These channels can be proprietary "web-based learning environments" or substantially different technologies such as interactive digital television or wireless, handheld devices, and devices yet to be devised. Intrallect's tools provide functions such as capturing and storing e-learning content and separating the content from any specific technology – that is expected to increase the longevity and flexibility of the knowledge and skills encapsulated in the e-learning content.

For DILAB, a first-mover advantage was identified when research on laser optics was combined with chemistry research among two science departments to create a protective, resistant-wear coating with a variety of industrial applications. Although there are other coating methods in the market, this process was confirmed to produce the best quality and provides the greatest flexibility for a variety of applications and prompted the scientists to create the company.

DILAB's initial application was as a high transparency and hard optic material for the defence industry – missiles, ray-domes and lasers. However, the Ministry of

Defence saw the potential of developing this type of technology for their own use and ended the collaboration with DILAB. This loss of a major customer required the DILAB founders to consider specialist applications that include sensory applications for hazardous and extreme environments – deep-sea, oil-well, explosive. Although DILAB is involved in contract negotiations to gain accreditation and specifications to enter into these markets, lack of a major customer and market has limited the ability of DILAB to emerge as an independent spin-out company. This limitation will be discussed further in section 9.3.2.2.

In the case of Spektra, an identification of 'new commercial possibilities and opportunities' occurred during a re-organisation of Schindler R&D, when founder Gordon Stuart, in particular, 'saw' the opportunity for the R&D centre to grow as a separate company. Realising that original technologies and knowledge developed as an R&D unit provided a strong base for exploitation, Gordon initiated the managed buy-out (MBO).

Unlike the other case companies, Spektra began with an existing market position in the highly competitive software sector having kept blue-chip customers from its previous business. An established market presence make it easier for Spektra in deciding to challenge the 'existing ways of doing things' in many other areas of the e-communication sector as a new company.

Unlike Yaba, ExpressOn and DILAB whose core technologies provided first-mover advantages, Spektra 'evolved' to a first-mover advantage in Scotland by replacing existing technological solutions with their own customised technologies. This advantage was accomplished by demonstrating to existing and potential customers that its solutions were more effective, efficient and therefore, superior to its competitors. The new company provided a level of flexibility, unavailable as an R&D unit of a major corporation, to identify and pursue other opportunities in the near future. However, re-focusing Spektra as a new company required significant changes to operations that will be discussed in section 9.3.3.1.

Despite the diversity of technologies, a common characteristic of case company founders and directors interviewed is an expressed longer-term belief in the commercial viability of their technology. In identifying a first-mover advantage from their technologies, most of those interviewed stated their expectation to further adapt their existing core technology, as opposed to designing a product for one niche market. Not only were these companies following a longer-term strategy of technological development, but each company, irrespective of their technology sector, was in essence following, in Freeman's terms (1982), "*an opportunist/offensive style of strategic innovation, as opposed to, and imitative, defensive or dependent style*".

It has already been described that Spektra's strategy is to constantly search for, find and explore potential new niches and marketplaces. For ExpressOn, the strategy in the medium term is to develop in-house antisensory agents against diseases of the brain and to sell them on to pharmaceutical companies at a much higher price. The strategy is to feed intellectual property into the bigger companies. ExpressOn's market strength is its development of the antisense platform technology that also provides licensing or selling opportunities as "*ExpressOn can't possibly do everything with the technology*" according to co-owner Eleanor Barnard.

ExpressOn also predicts that outsourcing of molecular technologies will expand rapidly in the next few years, and it aims to be at the forefront with the development of a set of tools which enables the genetic manipulation and analysis of a biological system. Molecular biology services are directed towards providing technological support to academic and industrial research laboratories. These services are focused on scientists who wish to apply these tools to their chosen system but who have no formal training in molecular biology, or who cannot afford the expense of re-equipping laboratories or re-training personnel.

The longer-term focus of ExpressOn is to finalise the technology and sell to pharmaceutical and biotechnology companies as a target validation tool. Antisense is emerging as a new class of drugs, although ExpressOn intends to sell to them

initially as a research tool. Peter likes to think that the key strategic advantage for the company is the potentially disruptive antisense design technology and the rise of antisense as a generic class of therapeutics.

In the case of Intrallect, the company identifies that it maintains 'considerable' first mover advantage since it spun out two years ago and that they expect to maintain competitive presence in the marketplace. Although they suggest that there is little direct competition in their market at present, due mostly to the results of impending take-over bids within the marketplace, Martin and Peter suggest that this position may change in the medium term as they become more successful and competitors react and re-focus.

In the longer term, Peter and Martin both suggest that one of the larger e-learning companies may take Intrallect over, although an obvious candidate is not identifiable. In the meantime, Intrallect's strategy will continue to focus on the ongoing application of e-learning modules for customers while securing a sustainable market presence based on ongoing innovation.

9.3.1.2 Entrepreneurial Vision to Start a New Company

Another common feature of the case companies was an identified individual vision and drive that supplemented to varying degrees the 'exploitation potential' of the core technology itself in prompting formation of a new company. Literature describes the special abilities, or personal characteristics, of the *entrepreneur* as a common characteristic in creating new companies. The importance of key *visionaries*, who are largely responsible for providing the *driving force* of a company, and are also largely responsible for the setting of the long-term strategic and technological directions of the firm, has been suggested for some time (e.g. Bennis and Nanus, 1985; Sashkin, 1987).

The particular 'entrepreneurial vision' of typically, either one person, or a very small group of individuals is as diverse as the technologies themselves. Within all of these companies there were typically one or two clearly identifiable individual/s who are characterised as mainly responsible for 'seeing' the potential commercial opportunities; in essence they were the visionaries. It is suggested that visionaries for the case companies were:

◆ Spektra Systems Ltd	Gordon Stuart
◆ Yaba Ltd	Dr. Gareth Jones
◆ AXEON Ltd	Hamish Grant
◆ Intrallect Ltd	Dr. Peter Douglas
◆ DILAB Ltd	Professor John Wilson
◆ ExpressOn Biosystems	Dr. Peter Esterbeiro, Dr. Eleanor Barnard

In conceptualising an entrepreneurial 'spectrum', it can be argued that one end finds the neo-classical entrepreneur, a market opportunist seeking profit opportunities. It is argued here that Hamish Grant of AXEON characterises the 'lone entrepreneur' whose drive and behaviour typifies the stereotypical market intermediary. Indeed, formation of AXEON can be characterised as following the neo-classical model of the firm that commences with the search for a profit opportunity in the marketplace.

AXEON was created around an explicit vision to gain a profit in the market, as stated by Hamish: *"We decided to aim high, with the goal to develop a high growth, world class, multi-million pound business in a five-year period, a dream that became AXEON"*. The vision created by Hamish and his wife Susan was based on their decision to return to Scotland and leverage their previous career experiences after a six month reflection of future opportunities whilst abroad. Both had decided that they did not wish to spend the rest of their working life overseas and wished to be more in control of their own business future. Hamish had initially gained a great deal of his business acumen working in the oil industry for British Borneo, with Susan developing an in-depth knowledge of the information technology sector. Upon arriving in the UK, they became UK distributors of SYSTEMS FX, a software

testing tools and services franchise. This provided Hamish and Susan with technical knowledge, business experience and capital upon selling this business that would be used in created their new company.

Hamish then began a search for a new developmental technology with identified potential market prospects that would allow them to realise their vision. He decided to contact a number of Scottish universities and entered into discussions with many of the industrial liaison and technology transfer officers in Scotland. Hamish found most of them to be at best 'unhelpful' and comments: *"It appears that for an entrepreneur to literally 'turn up at the door', asking for contacts with technologists and inquiring about the possibility of co-developing marketable products was not something that the universities were administratively able to cope with"*.

Indeed, it was only two universities, Edinburgh and Aberdeen, that were considered in anyway amenable to being approached externally by Hamish as a lone entrepreneur, albeit one with experience, enthusiasm and motivation. Hamish states that these meetings with technology transfer office were 'less than fervent', stating: *"We thought maybe it was because we did not really have enough pulling power to get the academics in Edinburgh and the others to talk to us. The reality probably was that for Edinburgh we were just too small"*.

This left Aberdeen University as the only university in which anything promising, in terms of potentially successful market technology, had been found; that being the processor research and technology that was to lead to the early prototypes of the Learning Processor™. This was considered as 'lucky' rather than 'planned', as they already lived in Aberdeen. Thus, the core product of AXEON was produced from technology that was being developed within Aberdeen University.

The creation of Spektra is also characterised by a strong entrepreneurial vision to pursue new market opportunities. Although it can be argued that Spektra followed perhaps a less risky strategy than AXEON, the decision of Gordon Stuart and his partners to initiate an MBO and spin-out was a high-risk decision given the

competitive nature of the software sector and the previous security of operating as a unit of a successful large parent corporation.

Moving towards the other end of the 'entrepreneurial spectrum', it can be argued that an entrepreneurial 'vision' is not a common, explicit and premeditated event within the academic research community. Indeed, literature suggests that remarkably few researchers have the ability to see or act upon such commercial possibilities (Howell *et al* 1998).

For some of the case companies, a particular milestone in conducting their research provided the '*eureka moment*' in the company's foundation. For Dr. Gareth Jones of Yaba, the possibility of creating a new company came when he realised a need for better diagnostic tests for chlamydia and the fact that an initial consortium looking to develop these tests was going to take too long. Gareth made the decision that converting to a platform technology would enable Yaba to produce new tests for chlamydia quite rapidly.

Faced with a potentially large market opportunity for human testing, Gareth on the one hand realised that a new company could exploit this opportunity, but on the other hand more research was required to develop the synthetic proteins that formed the test. Gareth identified a patented method of sticking peptides into plates by a Danish company and, perceiving this to be a good opportunity, contacted Scottish Enterprise to assist in negotiations with the Danish company and to validate the technology.

Scottish Enterprise, Gareth explains, was very helpful, providing advice and assessing the technology. The Danish company had an inflated idea of the value of the technology and in the end, Yaba decided that the asking price was too much. However, during this process of negotiations, Yaba looked at alternative technologies that they could use.

During the extended period when Yaba were operating as '*a one man operation*' this appeared to be exactly the type of entrepreneurial characteristic that '*saw them*

through to better times'. Yaba was existing as a one-person company, as Scott maintained his position as incubation manager for Pentlands Science Park. Gareth was taking no salary and Scott was not actually 'on the books'. As Gareth states, "Yaba was essentially 'working on free air'."

In the case of Intrallect, co-founders Peter Douglas and Martin Morrey identified '*external affirmation*' of their EuroMET technology in winning the European Academic Software Award (EASA) as the defining moment for committing to start the company. Peter elaborates: "*We always felt that these tools were very powerful, that we had done something quite clever, valuable and useful. The EUSA Award made us think that we should do something about it.*" Similarly, Martin states: "*Starting a new company had always been in the background as a possibility, but there was never any need to push it forward before. At the award, someone talked about commercialising an academic innovation that was timely and appropriate and inspiring.*"

Nevertheless, the driving force to commercialise Intrallect's tools was taken on by Peter Douglas although the entrepreneurial role has continued to evolve as a shared activity among the three founders. A key factor identified by Martin and Peter in forming Intrallect's was a 'pre-formation' partnership agreement made between the three co-founders regarding their individual commitment to the company immediately following the EUSA Award. All three founders had worked together for a few years on projects. Martin states they trust each other's judgement and also attributes Charles Duncan's attitude on the company as a catalyst for '*kicking the whole thing off*'. Because Charles was the leader of the research group, Martin suggests that he could have been justified in assuming a greater equity stake in the new company. Instead, Charles asserted that the company would be based on equal partnership, setting the tone for the partnership.

A further reflection of the positive relationship among the three founding partners can be seen through Martin's philosophy of his year working full-time to build the company. Despite being the only partner working on the company that year, Martin

views his commitment year as an Enterprise Fellow '*doing what the other guys most wanted to do*', while Peter and Charles worked less on the company and fitted it in during their spare time. '*It all evens out*', states Martin.

John Wilson of DILAB admits that he was the driving force to create the company, and admits in hindsight that he would choose his partners more closely, as the level of dedication and commitment to the company is not evenly distributed. One partner in particular has not provided the level of commitment, although at the time it was seen as important to include the individual on the team.

For ExpressOn, the leading edge science being developed in the new antisense technologies initially convinced founders Peter and Eleanor that their research efforts could lead to the creation of a commercially viable company.

9.3.1.3 '*Sustaining Strategies*' in Company Formation

Similar to AXEON and Spektra, each of the founders among the university spin-outs, although evolving to this realisation, became imbued with a strongly held belief in the commercial viability of their particular technology. In committing to a commercial route, a common theme among the university spin-outs was enacting some form of '*sustaining strategy*' for the company while developing their technologies, acquiring further resources and securing customers.

ExpressOn, DILAB, and Intrallect, for example, all offered consultancy services to sustain themselves while assessing the potential of company formation and spin-out from their respective universities (Bullock 1984). Another characteristic of these companies was reaching a certain '*threshold of technology development*' where sufficient market demand prompts the scientist to commit full-time to the company. How each company enacted sustaining strategies is described below.

For Intrallect, running a university-based consultancy prior to spinning out from the university allowed them to refine techniques and concepts developed in the EuroMET project that won them the EASA award. These techniques were used in several other projects, including the "National Learning Network for Remote Sensing" now being used by students all over the world. The consultancy leveraged the University of Edinburgh brand and also allowed the co-founders to run seminars in e-learning and produced bespoke software, including a system to enable a distributed team of editors to maintain a multilingual newsletter over the web.

For Intrallect, another key factor sustaining the company as it formed was Martin winning a Royal Society of Edinburgh Enterprise Fellowship Award that provided a salary for one year to develop the company. Once the three Intrallect partners agreed to set up a 'product' company rather than a consultancy, the first objective for Martin in the Fellowship was to write a business plan to take to investors. During that time, Peter secured another contract at Edinburgh University in another department while Charles continued as a full-time academic.

A Scottish Enterprise SMART award provided funding for Martin for another year, although the intention in applying for an award was to validate the technology to attract investors. Because a key selection criteria for a SMART Award is to verify an innovative product that is commercially viable, the partners expected SMART to lead to investment. Outside investment came in the form of a matching amount to the SMART award through a contact Martin met at a First Tuesday⁸ meeting in Edinburgh. Graham Bucknell, a business angel, joined Intrallect and immediately *'forced us to look on the commercial end'*, as Martin states, and organised the finances of the company. Graham has since evolved to become a non-executive director with Intellect in 2002. Following a SMART Award, there were enough funds in the company for Peter to join the company full-time.

⁸ First Tuesday is a national network for e-commerce businesses that provides monthly events the first Tuesday of each month (<http://www.firsttuesdayscotland.com>).

Edinburgh Technology Fund – Edinburgh University’s investment fund - provided approximately £10,000 that was used by Intrallect to ‘trial’ Gordon to undertake market analysis. Dr. Gordon Rankine, Director Sales & Marketing, has more than 25 years experience as directors of sales, marketing, commercial, and business, and has been CEO of a number of companies, the majority of which were start-up manufacturing organisations.

In hindsight, both Martin and Peter concede that this phased approach of joining the company only after each salary can be sustained saved the company from possible insolvency early on. As Martin states: *“If none of us had been able to take that risk, and just jumped straight into the business I don’t think it really would have happened. We were running consultancy work in our spare time but it would have been a real struggle to do long term”*.

Similar to Intrallect, ExpressOn began by providing contract research in molecular biology on a much more bespoke basis than the average research contract and thus were more like an academic collaboration but on a more commercial basis. This contract research provided Peter and Eleanor with an immediate source of revenue that was close at hand. Initial projects typically involved completing the last few months of a grant in which a researcher had left early or involved troubleshooting of projects where difficulties had arisen. These initial contracts evolved into entire projects from the university on behalf of other research groups needing input from an area such as molecular biology for multi-disciplinary projects – i.e. pharmacology – where they are not specialists.

ExpressOn’s experience in various contract research areas has provided the company with a broad base of expertise. Eleanor concedes that without the use of university facilities, it would have been very difficult to develop the company with their lack of funds. Eleanor and Peter purchased the same equipment for the company that they had used as academics, at a depreciated rate from the university. Eleanor asserts that this support contributes to their *‘love-hate relationship’* with the university that will be further explained in section 9.3.2.2.

Yaba's formation story involves simultaneous technology development and emerging market opportunities. Gareth acquired a SMART award of £45,000 in 1997 that allowed Yaba to hire two people to further develop the technology: first of all, the tests of chlamydial disease for farm livestock, called chlamydial abortion, and then later, developing a test for chlamydial infection in humans. It was during the human test that Gareth and the technologists identified what they perceived as a major market opportunity. At this time, there was an epidemic of chlamydial infection world-wide, placing the issue on the agenda of concerned governments and policy makers. The existing means to diagnose infection were very expensive and not applicable on a wide scale. Yaba felt that they could produce a test that was inexpensive, effective, automated and applicable on a wide scale. By using synthetic peptides in the test Yaba would be able to ensure complete specificity of the technology to apply to diagnosis.

DILAB, similar to Intrallect, Yaba and ExpressOn, received a SMART award that John suggests '*...was exactly the kind of money that we wanted to get started*'. The SMART awards allowed DILAB to develop its processing equipment, and they also developed a prototype that they were not expected to complete. The company also received a SMART II award, although John states that their advisor from Scottish Enterprise was incompetent, causing big delays in the application process. John also began giving presentations to potential investors but without receiving any strong interest.

DILAB at this time, John suggests, was somewhere between a real product and a service and was thus not a particularly strong investment opportunity. John states that he and his partners knew they had a technology capable of producing diamond coatings but at the time there was not a great demand for the application of the technology.

John's original idea was that DILAB would sell the equipment used for making the diamond coating because there were a growing number of research groups wanting to start in the field and there was only one supplier of reasonable equipment from the

US. This idea was rejected for a variety of reasons, but they decided to protect their idea while making sure they could develop the research side.

John says that the previous head of department was instrumental in assisting DILAB to use facilities, as this individual was involved in a commercial venture of his own and knew the issues and problems. At the present time, however, John suggests that Heriot-Watt University is only interested in a financial arrangement rather than other benefits accrued by the university from the relationship with DILAB.

The sustaining strategy for DILAB has been to remain within its university as it has yet to achieve a revenue threshold to sustain itself as a separate company. For DILAB, the challenge for the technology that exists today is cost, as many customers want an inexpensive application or customers want the application onto plastics, which requires a slightly different material application and process.

The key breakthrough required for DILAB and others in the industry remains to push costs down, rather than improve the technology. The company has costed out the possibility of spin-out and understands the threshold revenue requirements before there is any possibility of a spin-out option. Currently there is interest from an outside investor that may change the current position of the company.

Unlike the university spin-outs, AXEON's sustainable strategy in preparing to form the company involved a higher risk approach. Initially, not possessing the capital to generate and obtain the intellectual and financial property of their own company, they spent their time building up SYSTEMS FX as a simple software tools sales and distribution business. After growing the business in this manner for several years, they then chose to achieve additional growth within SYSTEMS FX by developing an additional on-line specialist business services aspect to SYSTEMS FX, aiming at achieving a turn-over of up to a million and a half pounds per year.

By 1997 AXEON had reached this level and employed a total of twenty two people, when they decided to sell the business to raise capital for their next and more

ambitious business venture (AXEON), deciding to move their family and base their new company in Scotland.

9.3.1.4 Leaving Academia: Personal Factors Influencing Spin-out Decisions

In describing his decision to leave the university to start-up Intrallect, Peter talked about the '*convergence of circumstances*' leading to an exit that include winning the EUSA award, his interest in further development of the tools and his absence of a rigid commitment to an academic career. Although Peter identified the freedom of an academic career as a benefit, the low salary, temporary contract (as a research fellow) and somewhat relaxed lifestyle were key personal factors contributing to a decision to leave academia.

Martin also states that his temporary research fellowship position did not provide much security and added that he and Peter did not have dependants at the time, making the decision to leave academia easier. However, both Martin and Peter conceded that, had they both been on permanent university contracts, the decision to leave and commit full-time to the company would have been more difficult. Charles, on the other hand, has only recently left Edinburgh University now that Intrallect is reasonably established. His decision has required greater deliberation and risk management, according to Martin, because of considerations for dependants (married with two children) and his tenured position with the university.

For ExpressOn, Peter and Eleanor decided that starting a new company was worth pursuing and that they would leave their university jobs. Eleanor was on a temporary contract and Peter did not hold a tenured position. Peter states that he never perceived himself as a career academic even though he spent 15 years in that capacity. He therefore didn't see leaving to start a new company as a high-risk option as it was giving up a job he actually didn't like. Eleanor states that she has no regrets in leaving the university and feels much happier working with ExpressOn.

She states she did not feel particularly well cut out for an academic and “*loves the commercial aspect of the business*” and balancing the lab and the commercial world.

As discussed earlier, John points out that DILAB as a company has not been built up to full success and the potential is there but has yet to be fully realised. There has not been enough business to date to make the company self-sustaining, thus no income has been taken from DILAB by its academic owners other than incurred expenses and related costs.

In hindsight, John says he and the other partners expected to get to the stage of full-time employment with the company much earlier. This creates what John calls ‘*the ‘Catch 22’ of academic entrepreneurship*’, where academics want to commit to exploiting their innovation and create a company, yet there isn’t a market that currently demonstrates high demand or justifies them leaving their university position. Related companies globally in the area of diamond coating have either folded or been taken over by larger companies that themselves have reduced considerably their respective product range.

John describes his position as an *academic entrepreneur*, that he defines as someone that has not yet left the university and continues to hold an academic position. In the most successful cases, an academic entrepreneur would ensure that commercialisation opportunities from the research are going to be used and not just given away, ideally through their own company and connections. He views the difference between an academic and ‘regular’ entrepreneur as one where the academic entrepreneur may not expect to make a living with the commercial opportunity. Once one leaves the academic side entirely, he or she is no longer an academic entrepreneur, John suggests.

A key problem for academic entrepreneurs according to John is that they often do not have to take on the risk of leaving their university. In his case, there is no special encouragement or great incentive to leave the university; rather it comes down to the individual’s perception of challenge, interest or ability to do something different.

John states that when DILAB was first established, the partners came to a reasonable agreement earlier on regarding the status of their existing positions, with three of the four maintaining full-time academic positions. John identified that he and his partners have been nervous about any of them leaving academia, particularly with the financial situation of the company.

Another reason making a departure from the university difficult is the existing ability to lease laboratory equipment and continue to generate new ideas and move product development forward with a direct academic link, even if this meant paying a licensing agreement with the university.

For John and his partners, the dilemma exists even if market opportunities arise regarding the company's relationship and position within the university. John concedes that there are others that may be more qualified to run the company but do not have the technical qualifications and linkages to research that currently exists at Heriot Watt University.

In terms of balancing the academic and commercial demands on his time and energy, John admits that this has been a challenge. With restructuring ongoing at Heriot Watt in 2002, John is becoming head of department that he anticipates will place greater pressures on time. John performs much of his DILAB work in the evenings where he comes across various ideas and concepts accidentally. Indeed, he admits that some of the best product 'pieces and bits' that the company has made have been totally unpredictable and have emerged from completely unforeseen directions.

9.3.2 Formation

9.3.2.1 Initial Investment

Case companies identified early stage investment, or 'seed' capital, from a variety of sources with no clearly defined pattern on how funds were secured or how funds

were used. A common theme, however, was that the level of initial seed funding was often far below what was needed to achieve initial business milestones set by the company.

Public schemes such as the SMART⁹ awards have been secured by each of the four university spin-outs to develop technologies and support salaries. The Edinburgh Technology Fund¹⁰ (ETF) is another public scheme successfully tapped by Yaba and ExpressOn to file their patents and by Intrallect to undertake market analysis.

Some companies obtained a ‘mix’ of early stage public and private investment. *Debt financing* was used by ExpressOn in the form of a £10,000 bank overdraft secured with assistance from the Edinburgh Chamber of Commerce who helped with their business plan and provided an introduction to the bank’s commercial lender who ultimately provided the overdraft. This was followed by ETF investment to secure patents and fund a one-year pilot project.

Yaba also identifies a ‘mix’ of early stage investment that began with investment from ETF followed by venture capital from 3i that together provided an initial fund of £120,000. Although Yaba identified its early-stage milestones to be specific patents relating to the human chlamydia test and animal chlamydia tests, this level of funding was below what was needed to achieve Yab’s identified milestones. However, by 2001, Yaba had raised approximately £450,000 for the development of its intellectual property rights (IPR) and the company’s first product Panclabort. This subsequent funding involves seed venture capital from Scottish Enterprise and 3i, UK Government grant funding through SMART stage 1 and stage 2 awards, loans and directors’ funds.

Other companies, like AXEON, sought a broad range of early stage investment beginning with personal savings, debt and private equity from multiple sources.

⁹ Eligibility for SMART requires applicants to be an individual resident in Scotland planning to set up a business in Scotland, a sole-trader, partnership, independent company or part of a group operating in Scotland with less than 50 employees (i.e. a small enterprise) and have a highly innovative R&D project that may lead to the introduction of new products or processes (Source: http://www.scotland.gov.uk/who/elld/rnd_SMART_1.asp).

Hamish and Susan invested approximately £300,000 of their own money in AXEON. money generated from the sale of SYSTEMS FX. Then AXEON obtained approximately £335,000 equity and £200,000 debt finance early in 1999. The equity finance was provided by a combination of institutional investors, such as 3i Plc and Scottish Enterprise and Business Angels, such as The Sutherland Consortium. The Bank of Scotland and Grampian Technology investments (Grampian Enterprise) provided the debt finance. AXEON used this mix of early stage investment to develop the Learning Processor™ from the conceptual design phase to the fabrication of early prototypes.

Hamish suggests that obtaining seed funding was not particularly difficult, and he expressed a belief that they had developed a good initial business plan, based around a viable technology. Indeed, Hamish comments: *"...that [seed funding] was relatively straight forward to obtain"*.

A key concern identified by each case company in securing initial investment was the amount of time taken up with the search for funding from a variety of sources. Hamish suggests that the 'tying-up' of senior personnel seeking investment is a particular problem. He states: *"When you have five people in your firm, two of those five people may have to get involved solely in doing the deals and that may paralyse them and your business for three months while they could be getting on with other crucial business tasks and that is the most difficult aspect of it [raising funds]"*.

Hamish continues: *"Waiting months for finance is no good when you have to pay people salaries, pay building rent and so on, every day"*. Hamish identifies the challenge of dealing with private investors also in terms of the time constraint and states: *"The biggest difficulty was generating the aspiration from the capital funders to do a money deal quickly. The reality is that they are often monoliths and they still have to go through their monolith processes so it all can take a long time if you are not careful"*.

¹⁰ ETF targets the world-class research community in and around Edinburgh, seeking to invest money in emerging technologies, and research entrepreneurs, that demonstrate the potential to establish new commercial opportunities capable of generating significant income to be returned to the community (see Appendix I).

In terms of the public schemes, some case companies stated concerns over the *'masses of forms and regulations required'* contributing to longer lead-times to obtain investment. As described earlier, John of DILAB states *"the application process for the SMART II award was a bureaucratic nightmare"*, with an advisor who contributed to big delays in the application process. At the same time, John stresses that the SMART award was *"...was exactly the kind of money that we wanted to get started"*. The SMART awards allowed DILAB to develop its processing equipment and a prototype.

Eleanor from ExpressOn found that securing a SMART award diminished their ability to secure the maximum of £250,000 from the Small Firms Scheme because of the ceiling of the European limit of support in any three-year period. Although SMART II is exempt, a company can't go to SMART II without SMART I, and Eleanor feels that SMART I should be exempt.

However, similar to DILAB, ExpressOn credits their SMART award to attracting renewed interest in the company by venture capitalists. Eleanor adds that seed funding was made difficult because, at the time, there were few seed funds available for biotechnology and they were fortunate to secure an ETF grant. Eleanor feels that a SMART Award is necessary for a biotechnology company to endorse its technology. The SMART was used to refine the technology to be a predictive tool to identify antisensory agents that 'knock down to different levels' to allow for a range of drugs effective for each particular gene.

Particularly for Yaba and ExpressOn, an additional problem identified is the longer time horizon over sectors such as information technology and software for investors of biotechnology due to the often very long technological development lead-times. Peter of ExpressOn argues that part of the issue is for private capital to understand biotechnology and decrease the pressure to exit quickly. Short-term risks are very high, and he suggests that 8-10 years is required in many cases to generate the returns expected by venture capitalists.

Yaba and ExpressOn founders' experiences suggest that many venture capitalists simply do not have the longer-term view of investment and explicitly avoid biotechnology companies. Both companies identified examples of high-potential Scottish biotechnology companies [names withheld] that have been undervalued and sold off because venture capitalists took their money out early rather than wait until reflects higher value. Gareth suggests that a focal group in Scotland should be created to provide a check and balance for this type of VC behaviour as well as to educate investors on investment issues particular to the biotechnology sector.

Yaba identifies a number of investment challenges faced in securing investment for their *diagnostics* tests; an area that Gareth suggests is not the “sexy” part of biotechnology. The reason that Yaba chose diagnostics was because it is sustainable and they could get a number of products into the market. Yaba now has one product and a potential second product in the pipeline, which, if they secure adequate funding, will provide a solid business in both veterinary and human diagnostic testing.

Although diagnostics provides a platform technology that enables other technologies to develop very rapidly, the challenge for Yaba has been to secure enough money to employ the people to focus on specific tests, with the same platform technology used for all these different tests. Thus, the rate of progress is rapid and not constrained by the technology. The investment gap for Yaba is identified as the funds needed to hire the people to develop these tests.

One angel investor group turned Yaba down for investment because they felt the company should market themselves. Yaba's marketing strategy was to sell directly into laboratories, identified by Yaba as a large market. Gareth and Scott, from quite an early stage, felt that in developing products for human diagnostic tests, they would not take on board their own marketing of the technology. Marketing into the human arena, Gareth points out, is a massive undertaking. Yaba was instead looking to license or sell the entire package for any human tests that they developed.

Another challenge for Yaba related to investment has been in valuation and due diligence. Gareth suggests that VCs wait until they get verification on a particular technology from someone they respect. Any generalisation of business investment may not apply to biotechnology, so investors may need a strong biotechnology background to spot and understand the value of the opportunity.

According to Gareth, for many investors the expectation for due diligence is *“let’s look and see if the valuation is correct”*. Yaba is undergoing due diligence by a neutral body at the moment, which has been commissioned by Scottish Enterprise. The due diligence document is getting paid for by one of Yaba’s investors. If Yaba does get funding, they will have to pay for that due diligence. Scottish Enterprise has defined the scope of the due diligence and this is the first time that Yaba has gone through a structured due diligence process. Gareth and Scott were somewhat surprised that there was no initial significant discussion with the people that would perform the due diligence, in order to *“get to the bones of what Yaba was about”*.

The problem with using business plans for due diligence, Gareth argues, is that they have to be toned down so that they are readable. It became quickly evident by those performing the due diligence that the business plan was a totally unsuitable document for them. They realised that Yaba had far more than what was within the scope of the due diligence originally outlined by Scottish Enterprise.

From Yaba’s perspective, it is the role of others, such as financial intermediaries, accountancy firms etc., to take on the role as an independent body that acts as a conduit between the company and the venture capitalist. But it hasn’t worked that way for Yaba. On the other hand, if Yaba paid for its own due diligence, there would be a question of bias. As Gareth notes, there can be a considerable conflict of interest when it comes to valuation of a company.

One criticism noted by Peter at ExpressOn about biotechnology in Scotland and the UK is that many spin-out companies actually emerge, but there is not enough emphasis placed on growing these companies and generating a critical mass of them.

Peter argues that Scotland has the potential for building of critical mass of biotechnology companies and creating a virtual pipeline to take forward technologies competitively without mergers and acquisitions. Instead, Peter suggests there is a high merger and acquisition dynamic in biotechnology.

Peter identifies that ExpressOn has benefited from people who understand the issues of biotechnology. He cites attending Connect meetings where they met Keith Winton of Edinburgh Technology Fund and secured £100,000 that funded a one-year pilot project. Eleanor feels that setting up the company, having a business plan and demonstrating commercial intelligence in terms of winning contracts - as it is unusual for a biotechnology to have any revenue stream in its early years - convinced Keith of the potential of the company. Eleanor feels that commercial credibility of ExpressOn is made difficult by the fact that two academics are attempting to set up a company on their own.

A common theme in securing early stage investment by these case companies is the trade-off between the cost in time needed to establish relationships with various investment sources or complete applications and the uncertainty of investment success. Initial time and effort is required to initiate hands-on and realistic relationships with investors, and the importance of intermediaries is identified by ExpressOn in securing its bank overdraft and the Connect network in meeting investors such as Keith Winton of ETF.

Public schemes such as ETF and SMART are identified as critical to early stage technology development, patent filing and market analysis but qualified by the problems of bureaucratic constraints as experienced by ExpressOn and DILAB.

However, as time passes, companies attempt to seek further rounds of investment, investment relationship develop and evolve. In the case of companies like Yaba and AXEON, for example, having a strong, well constructed and realistic business plan is one thing, yet high-technology start-ups will most likely face unforeseen technological problems and the need for further development. For many start-ups,

this will prove to be an insurmountable problem. In the case of Yaba and AXEON, a prolonged '*product development to market*' phase has resulted in investors questioning their projected financial returns, thus delaying investment until other investors are found to share the risk or technologies are further developed and markets and customers confirmed.

9.3.2.2 Intellectual Property, Licensing and Issues with Universities

The notion of protecting, licensing and owning intellectual property (IP) and dealing with universities was expressed as a 'complex issue' for the case companies, but was nevertheless considered highly critical to protect the companies' prime-mover and industry standardisation advantages. Indeed, IP was one of the specific issues mentioned time and again that the firms wished to find out more about by joining communities such as Connect, as the cost of employing specialist lawyers is identified as prohibitively expensive in many cases.

Protecting technologies with patents is particularly critical to maintain first mover advantage while companies continue to develop the technologies. ExpressOn, for example, has ongoing patents pending on a number of techniques that they use to develop their antisense technology, requiring constant attention to IPR issues. This does not mean that patenting follows a predictable pathway directly linked to completion of technological milestones. Although ExpressOn filed an initial patent to protect its early antisense technology, the technology moved on quickly during ongoing development, differing from the original patent request.

Eleanor concedes that there was benefit to holding off on patenting their developments and the company is now at a stage where they have been put in as a Patent Co-operation Treaty¹¹ (PCTs) file and initial search results from the patent office are coming in. PCTs effectively delay the decision for a year and adjustments

can be made in the meantime. Once patent results are in, the company will make decisions on the scope and breadth (geographically) of protection.

Similarly, AXEON has a patent on the Learning Processor™ and also has a patent pending on a number of other core-products. They have been highly careful to maintain a great deal of control over their IPR involved with their technological developments. This seems a prudent lesson as it is often suggested to be near impossible (or at least extremely difficult) to develop into a world-wide and successful producer of microchips without huge amounts of funding, presumably diluting further the founders control of their company.

However, AXEON is different from ExpressOn in that it licensed its core technology derived from Aberdeen University. Hamish explicitly expressed the notion that licensing their technology was a ‘way forward’, together with the increased pursuit and expansion of their developmental partner programmes. As mentioned earlier, AXEON sought a likely candidate technology and hoped to cut a *‘very sensible umbrella deal’* concerning intellectual property rights and royalties, as Hamish states. This deal provided access to key, world class researchers at the university as well as to the potential technology. In June of 1998, the person whose PhD originated the idea of the Learning Processor™ - Dr. Neil Lightowler- was hired. As Hamish puts it: *‘We got him on board as we needed to move from a PhD thesis to a business model that we could get funded, the situation was that the individual owned the idea not the actual university and this is where we wanted to get to’.*

As well as beginning to launch its own range of products, AXEON is actively engaged in seeking product development partners who wish to apply the Learning Processor™ to their own respective products. Such a targeted business model suggests that AXEON is highly committed to developing relationships with potential alliance partners to develop the licensed application specific solutions for a variety of market sectors.

¹¹ PCT is a world-wide system for simplified multiple filing of patent protection from a single application that is applied to a large number of countries simultaneously.

In the medium term, AXEON plans to pursue the business model of IP Core supplier, in the long-term they believe that to gain a high level of technology adoption, the company must focus on specific markets and utilise its technology within chip-based products that provide *specific* solutions to *specific* problems identified within the industry in general, and more precisely, by the customer.

For the university spin-outs, all identified particular problems in dealing with their respective universities and securing ownership of the intellectual property.

The initial step towards setting up ExpressOn occurred through a meeting with Edinburgh Research and Innovation (ERI), Edinburgh University's technology transfer office, in the summer of 1999. Peter notes that the proposition that was taken to ERI was a means for a very rapid design of antisensory agents, to reduce the time and expense of design. The proposition was to provide relatively small biotechnology and pharmaceutical companies to undertake genome-scale projects that might otherwise be accessible only to large multi-national pharmaceutical companies. It was on the scalability of antisense design that ExpressOn as a commercial opportunity has been based.

Peter concurs with Eleanor in suggesting that he would have clarified his personal IP position at the time that he signed his first contract with the university. He argues that the key issue was the fact that ERI owned the IP yet chose not to exploit and protect it themselves or support the company seeking to exploit it. Peter suggests there are one or two people at ERI that can be difficult and that the university is very risk averse, telling Peter and Eleanor "*not to 'pester' Keith at ETF*". Yet they did meet Keith at a Connect event and found that they were exactly the type of company ETF was set up to support. Peter argues that ERI should have encouraged and supported their application to ETF.

University support for ExpressOn did come from a former head of department, who arranged for Eleanor and Peter to lease lab and office space in the department. A new head of department has not been as supportive as the previous head. One

consideration, noted by Eleanor, is that the rent actually is not realised by the department but is rather secured centrally by the university. At the same time, pressures on the department to consolidate space resulted in a situation where the department was being paid to make office and lab space empty for new initiatives. Peter adds that the former department head buffeted them against the negative attitude of the university and particularly the Faculty of Medicine that was very much against ExpressOn at that time. Peter notes that there were individuals within ERI that were supportive of the company, but ERI formally did not support the company.

Peter and Eleanor took legal advice in their attempt to get assignment of the IP from ERI and succeeded eventually to set up the company in September 1999. ERI decided that the intellectual property (IP) was too complex and difficult to patent and protect and would be too expensive and consequently turned down the option of being involved. ERI were difficult during this time over intellectual property, according to Peter, and at one stage offered the company a two-year non-exclusive license.

The end result was a letter from ERI that signed off intellectual property to the company. As Peter asserts, this assignment was a necessary condition to securing ETF funding and gaining subsequent interest from venture capitalists. Eleanor states that they were advised to take a 'soft approach' in dealing with the university and achieved it through personal negotiations.

Eleanor feels that they set up the company '*in spite of ERI*' as their experiences with ERI were not particularly helpful. At the same time, the company does have an ongoing relationship with ERI as the company subcontracts with the university to carry out entire projects on behalf of customers, some of whom are located within Edinburgh University. One recent example is completing a pilot project for an academic needing to demonstrate the commercial viability of a project, much of which has been outsourced to Eleanor and Peter.

In hindsight, Eleanor feels that it was wise that they didn't set up as a university spin-out because ExpressOn is independent of the university – ERI holds no equity – although ETF is a shareholder. At the time, however, ERI's lack of support was a source of frustration and disappointment. ExpressOn rather than ERI have generated subcontracts with departments at Edinburgh University. ExpressOn also plans to contact other university technology transfer offices to promote their services, and this effort will not be actively pursued on the company's behalf by ERI.

Peter is adamant that much of the commercialisation support provided by ERI could be out-sourced, as many of the advisors may have science or management degrees but are lacking in relevant commercialisation experience. This argument will be picked up again in the section on complementary support programs.

Intrallect's experience is similar to ExpressOn's. As Peter Douglas states, "*the process of actually assigning the intellectual property (IP) signed over to Intrallect has been long and arduous, unnecessarily so*". At the same time, both Peter and Martin noted the their contact person at ERI provided key support in the early stages. This individual suggested that they first set up the consultancy rather than going directly into a spin-out, and also helped with the SMART Award application.

Initial contact with ERI at Edinburgh University had occurred while Martin, Charles and Peter were providing consulting outside the university with its contracts directed through ERI. The consultancy provided Martin, Peter and Charles with a business identity, logo and website, and this consultancy, Martin claims, was a factor in eventually securing the Research Fellowship. Peter is quick to point out that both the consultancy and ERI benefited from this arrangement as ERI takes a large percentage of the contract.

Peter suggests that there was little encouragement from ERI to spin-out of the university up to this point. The initial consultancy support from ERI suggested in 1999 that the opportunity was for a start-up with no IP issues. But as Intrallect attempted to spin-out by 2000, ERI took the position that the university would

licence the IP to Intrallect. As Martin states, this is no use when attempting to raise investment. But a sudden shift in ERI's position – with ERI moving to *'the other side of the table'* occurred as Intrallect moved into a potential spin-out position, according to Martin.

Following Intrallect's presentation at the 2000 Connect Investment Conference, the profile raised through the conference gave notice to ERI of the value of Intrallect's IP, according to Martin. Just prior to the conference, in order to provide a vehicle for depositing the SMART award and initial investment from Graham Bucknell, Intrallect was established as a company with ERI not a shareholder. Immediately following the investment conference, negotiations for IPR began with ERI concerned that they were not a current shareholder.

Interestingly, both Martin and Peter argue that the IPR was of little value to anyone else. In fact, Intrallect didn't use any of the technology that was on the CDs that were part of the IPR assignation. As with many software products, Intrallect expected that their software was going to change and evolve, and the technology was not as valuable as they initially thought, rather it was the business processes and applications that were more valuable. Software value, according to Martin, requires continuous maintenance, upgrading and improvements and the original product's software was outdated by the time IPR negotiations with ERI began in 2000.

Previous advice, identified as complementary and free, was then identified in the IPR negotiations as something to include in the negotiations. Edinburgh University initially wanted *undiluting shares* and ended up with 5% share. In hindsight, Martin suggests that back in 1998, the partners would have been willing to give the university 15%.

Intrallect's advice to other spin-outs is *"to get a clear agreement from the university from the start – in terms of assistance and provide standard principles for exchange of IP or get clear advice from a third party that is familiar with these issues, such as Ian Macdonald of Connect"*. Another piece of advice from Peter is that things in the

universities in general take a long time, and this time is highly critical during company formation. Peter feels that, in this regard, dealing with ERI was a significant barrier over the IPR issue that added perhaps 6 months to the process. Part of this problem was also the unclear situation of ERI providing initial support through one source and then having other players enter the negotiations with different outcome expectations.

The experience of DILAB provides another example of the '*enabling and constraining*' role of universities similar to those experienced by ExpressOn and Intrallect. Back in 1994, John and Philip contacted Heriot-Watt University's commercialisation office to discuss commercialisation issues and found the initial reaction to be ambivalent. John states that their advice was to "*follow the rules for IPR, register things, ...we can't invest, we don't have any special interest and carry on*".

There was no commercialisation route at all, John concedes, for start-up companies, although there was a consultancy route for academics through the commercialisation office. "*They really didn't know what to do with us*", John states, but after a few months when they realised DILAB was still going and was attracting some business, the commercialisation office called a second meeting to discuss shares without a corresponding input of money or services. At this point, John says it was too late as DILAB had external shareholders.

John concedes the university commercialisation processes have evolved since that initial meeting. No preferential treatment was provided and DILAB was treated like any other company coming to the university and were offered lease terms for the use of facilities and equipment. DILAB was not able to use the university name because HW was not a partner. The university suggested that DILAB take a place in their Research Park but the company turned it down as it was too expensive.

Currently, both the university and DILAB benefit from the existing 'loose arrangement' that John admits is a '*strange partnership*'. Should the current

scenario change, DILAB would most likely remove its equipment that is located in university labs and effectively stop some of the research that benefits both parties.

John points out one advantage of the current position within the university. He states that the commercial 'problems' faced by John and the other partners that are pure research ones are usually run through the university research links especially if there is uncertainty regarding a problem's potential commercial outcomes. This allows for a variety of people to query the processes for finding solutions to research questions when they arise. John states that a visiting German academic to the department was instrumental in assisting them with a microwave application now incorporated into DILAB's technology.

A trade-off to this set-up is that John and the others must create the time to complete this work in addition to performing their academic responsibilities. In the previous university contract for outside research, John says this set-up allowed for one day a week to be dedicated to outside work. However, the more recent contract does not provide that option.

Another advantage for DILAB within the university is that students and research associates provide a variable workforce for DILAB, as they do for much of the applied research at Heriot Watt. John says that DILAB tends to get problems that others cannot solve, providing DILAB with two options. The first is to attempt to convince the customer to enter a longer-term contract where DILAB will look at the problem closely and build it up. The second option is to look at the problem quickly and say whether a solution will work or not. John states that it is very difficult to get British industry to do long-term contracts that involve investigative research.

A related spillover effect of using postgraduate students is the commercial experience they gain in working with DILAB. Two of John's postdoctoral students working with DILAB went into industrial jobs, while three PhD employees worked with the company. Since DILAB began, other commercial ventures have

commenced in the physics department that John suggests may have been stimulated by the efforts of DILAB.

9.3.2.3 Scotland as a Home Base

Case companies suggested that Scotland is a good region for setting up their companies for a variety of reasons described below:

- ◆ The concentration of several world-class universities and other educational institutes in a relatively small area.
- ◆ The proximity to 'silicon-glen' (for IT-based firms in particular) centred around Livingston, home to a large concentration of firms.
- ◆ The relative cheapness of premises.
- ◆ The number of support programmes available to new companies.
- ◆ The high standard of living for the founders.

Spektra Systems, originally an R&D unit of the world's largest manufacturer of elevators, Swiss corporation SchindlerAG, was established in Livingston because of the concentration of world-class universities within 30 minutes drive with strong computer science and artificial intelligence departments. The presence of a mass of other software companies in Livingston, known as the centre of the Scottish 'silicon-glen', was another reason for locating in central Scotland.

That did not mean to say, however, that Scotland was considered the *only* place to base the company. All of the firms reviewed expressed the clear understanding that there are several other places in Britain, and the world, of great importance to them, and that many market, finance, human resource and developmental partnership opportunities existed elsewhere. Indeed, it was a source of query from case founders that the members of Connect Scotland did not have direct access to other international Connect programs around the world.

For AXEON, Aberdeen was chosen as its base for both personal lifestyle and family reasons of the founders. Indeed, Hamish states that he knew many established entrepreneurs in Scotland who had also chosen to establish themselves there for similar reasons. That is to say, the favourable perception of the standard of life, cheapness of housing and business premises and availability of a well trained and motivated workforce allied to many new firm start-up support programs and university technology transfer offices all have a large bearing on where entrepreneurs chose to establish their firms, as well as where to live themselves.

Both Peter and Martin of Intrallect stated that Scotland is a good place for setting up a new company. The Company's site in Livingstone is convenient for commuting from Edinburgh, where all three partners live.

9.3.3 Growth

9.3.3.1 Responding to Set-backs

Another set of challenges facing each of the case companies has been attempting to balance science and business responsibilities following successful company formation and responding to various set-backs. Clearly, growth of these technology-based companies demands a great deal of protracted research and development that must go hand in hand with the growth and establishment of other aspects of the company; that is to say, the hiring of staff, the search for new investment and revenues and adoption of more formal management practices. Many of these challenges are identified in evolutionary stages of firm growth (e.g. Mount *et al* 1993; Bhida 2000).

The problems that Hamish of AXEON faced in the development of his core technological platform were manifold, beginning with investment difficulties holding up further technology development. These funding difficulties also led to the sort of

‘business paralysis’ Hamish suggests is a problem faced by many start-ups. He adds that at least four months worth of progress was lost.

AXEON’s competitive strategy, after all, was based on the belief that to gain a high level of technology adoption, the company must focus on specific markets and utilise its technology within chip-based products that provide specific solutions to specific problems identified within the industry in general, and more precisely, by the customer. Without developments in their technologies, AXEON would be unable to commence discussions on licensing agreements, develop partnerships, set up technological standards and so on. The long-term business aim of providing a combined product and service offering from IPR and Licensing agreements would be seriously jeopardised since AXEON did not actually manufacture the technologies themselves.

Hamish suggests that this period, although stressful and uncertain, was actually crucial for the future development of AXEON. It was said that it would have been all too easy to sign away huge portions of the equity of AXEON ‘in panic’. Once again the founders of AXEON displayed an ability to ‘step-back’ from their business and think about not just the ‘here and now of doing business’ but also their ‘long-term wishes for the firm’; a lesson that it is suggested too many entrepreneurs may fail to heed. He states: *“By using this time to take stock and have a long look at ourselves and see what we wanted to do, how we wanted to do it and what we were prepared to put in and take out of the firm, we did not feel lost or panicked. By focusing on the long-term vision it kept us on track”*

Hamish suggests that AXEON were able to ‘re-group’ with a stronger sense of purpose, growing the firm to eight people. Hamish sums this up by stating: *“By now we had begun to prove our technology and we had a much clearer idea of our potential markets and where we intended to go and what we had intended to achieve with AXEON”*

This 'stock taking' meant that they also now had a better idea of how to manage their current and future relationships with their investors. He states: *"The new Business Angel investors and the existing investors were fundamentally different from each other. First and foremost they [the Angels] were business people and not, for example, Government civil service people. As such, they recognised our business needs much better. They recognised that they were not simply going to invest but also help us actually to raise, say, three million in the future that I will need. They recognised that I need a large sum of money, to have some financial security and to go out and hire people, already in the bank and not after the fact"*.

As well as beginning to launch their own range of products, at the middle of 2001, AXEON continue to actively seek product development partners who wished to apply the Learning Processor™ to their own products. Initially, the company had planned to focus on providing solutions to the network management market. These first products aimed to focus on providing Internet bandwidth acceleration and optimisation for Internet Protocol-based fixed and mobile networks.

This targeted business strategy suggests that AXEON is highly committed to developing relationships with potential alliance partners to develop the application specific solutions for a variety market sectors, as well as providing a comprehensive programme of tools and support for these partners. It is in this future challenge that one may see the benefit of developing clear and mutually supportive relationships with financiers, potential partners and supporting agencies. These aims have been instrumental in AXEON becoming involved in Connect as a 'social' support and networking program.

Growth challenges for Intrallect are evident now that the company is becoming successful. Intrallect's growth to 2002 can be described as 'organic' and the risk of overtrading is an identified risk according to Martin. Current tenders, should they materialise, will stretch the existing resources of Intrallect. Martin and Peter suggest that the skilled workforce needed to grow is available in the region.

In the early stages, Intrallect outsourced their software development to an outside company that subsequently ceased trading. As timing would have it, Intrallect was recently able to secure two of their software engineers and have others on temporary contracts. Martin and Peter concur that this recycling of skilled labor is occurring particularly in the software sector in 'Silicon Glen'.

Since its software has application to a variety of sectors, Intrallect has recently entered into agreements with other companies that represent them in different industries (Aberdeen in oil and gas) and in different regions - Australia and the USA.

In Yaba's case, initial difficulties in negotiating for a patented technology, due diligence and investment challenges slowing testing development have forced the company to explore other new technological avenues; avenues that were to prove much more successful. Re-focusing on veterinary and human testing and development of the current technological products have arisen from changes to the initial strategic objective that Yaba had intended.

Spektra's growth challenges can be traced not to investment constraints and technological difficulties as much as to re-directing a successful going concern. As Euan states, the MBO agreement was a double-edged sword. On the one hand, it allowed Spektra to invest in technology that has put Spektra where it is today. Financial security ensured that debt financing or outside investors were not placing restrictions or forcing strategic decisions on Spektra.

On the other hand, there was no real consistency to what Spektra was doing. Spektra was delivering solutions to what customers wanted and delivering to large companies that Spektra had previously developed relations with as a unit of Schindler: large customers such as Hitachi and Hewlett-Packard. These companies continued to see Spektra as a very good development unit.

Following the MBO, Spektra went from being part of a cost centre to an independent company, focused on sales of business-to-business, e-commerce, and java-

enterprise-based services. Spektra had very quickly decided after buying out from Schindler that there were potential benefits with Java, but didn't know precisely what. At the time, they could see its value in terms of the internet space,

The first thing that Spektra did was to reengineer much of the software that they had previously developed for Schindler; C C++, unix shell script, and service-side Java. The critical point is that Spektra did a lot of development on the service side at this time. If the company had chosen to go off and re-implement user interface in Java, Russell cautions, they might have had a significant number of problems, such as the early problems experienced with Java.

Euan stresses that the whole thing about setting up new technology is developing support for it; people who are in the marketplace who have those skills to use that product and deliver it. To this point, Microsoft had put a program together where they had identified centres of excellence, so that when they went to a big client, such as a bank, they could provide local support for any system they introduced.

Spektra identified that if the company continued to want to work with blue-chip clients in Scotland, it needed to have the backing of a big player. Spektra negotiated a deal with Sun Systems and decided on Java. There was a strategic intent behind this initiative, Euan points out. In the market, the tide was turning against Microsoft as the way to deliver serious support. Spektra had recognised that a strong presence to back professional sales was critical. Spektra had decided in anticipation of where the market was heading, and chose the main delivery platform in Sun Systems. Thus, Euan relates the importance of the technological development aspects of the core product to the continued growth of the company. In essence, he suggests that they must go 'hand in hand'.

The challenge now for Spektra is to grow in a linear function; as size does matter with economies of scale in sectors such as software. Spektra is now confronted with a whole series of new challenges to business growth as it "stretches at the seams". Business at the moment is very much service based. As the company grows; so does

overhead, therefore there is a critical focus of the sales function toward business relation development over a wide client base.

However, in the case of DILAB, lack of a sustaining market to allow the company to develop has placed the company in '*current suspension*'. John concedes that they have not attempted to secure large investments because they cannot justify it and do not need it at the moment. Should a large customer emerge, the financial partner has suggested that the company will turn to the banks to secure funding rather than engage venture investment. In hindsight, John suggests that a rapid commercialisation move early may have launched the company, but also points out the demise of similar companies in the sector.

9.3.3.2 Growth Financing

Despite time delays and application challenges, securing early stage 'seed' funding was identified by most case companies as a successful process. However, subsequent rounds of investment have been described as significantly challenging.

AXEON's 'consortium' of early stage funders that included venture capitalists 3i and Scottish Enterprise, were on the whole 'minded to re-invest', Hamish suggests: "*They were not without their strong reservations about the likelihood of turning this venture into a commercial success*". Concerning this reticence of existing funders to re-invest, Hamish claims: "*Their fundamental issues were, I think, probably that we were being too ambitious. They had some concerns, on the market projections for our business growth and particularly on the technology. Fundamentally we have learnt a lot from that and have adapted our strategies accordingly*".

Similarly, with the search for second round funding came a re-evaluation of the personal criteria for developing AXEON (and SYSTEMS FX) in the first place: a criteria that seems highly influential throughout Hamish' and Susan's business lives, that of having a large sense of control in their own business future.

Clearly the initial aim of attracting seed funding was related to the simple and pragmatic goal of getting AXEON off the ground. Yet with the previously stated long-term personal goals in mind, it was felt that with the search for second round funding the founders might have risked losing a good deal of the strategic and financial control of AXEON to their investors.

Accordingly, Hamish and Susan expressed a wish to find alternative investors as they wanted to be sure that they were not giving all the company's equity away. This meant that the process of obtaining second round funding eventually dragged on longer than was hoped for. As Hamish comments: *"We let the process run on far too long and eventually we had quite a large potential syndicate of investors. The problem was we took the eye off the ball about getting our existing investors absolutely convinced that they were going to fund us on mutually suitable terms. In trying to get new investors, we forgot, or at least didn't pay enough attention to, our old ones"*.

Eventually, after a good deal of complex negotiation with their existing funders, allaying fears concerning the development of the technology and potential commercial success and the possible loss of control for the founders, several 'mutually beneficial' deals were struck to provide approximately £660,000 of second round funding, from a mixture of existing and new investors.

Eleanor of ExpressOn states that they experienced a funding gap in seeking a second round of investment of £500,000 to £1 million because this amount is too big for seed funding and too small for most venture capitalists. Another problem they experienced was *"getting quite far down the road with one venture capital firm but then finding out that their offer required that we merge with another company in their portfolio"*. In starting the process over again, ExpressOn was about to close again when one of the VCs dropped out of the syndicate, requiring another 6 months to build the syndicate up.

Currently, ExpressOn is closing a second round of funding from venture capital to finish off the prototype, although the original concept turned out not to be workable. But Eleanor concedes that it has taken over two years to secure this second round of funding, echoing a common concern from other case companies that obtaining further rounds of funding has proven to be a much more difficult task. Peter adds that the message from VCs to ExpressOn was to complete the development from which a larger amount of funding could be secured. ExpressOn was at a stage where it was still considered high risk because they had still not finalised the development of the technology.

Gareth and Scott of Yaba point out the importance of public schemes and debt financing to “*keep itself afloat*” while seeking its second round of investment. Yaba used a SMART 1 followed by a SMART 2 award, then acquired a small loans guarantee from a helpful bank manager followed by a business growth fund. Yaba began seeking second phase funding in November 1999 and secured a substantial six-figure deal in 2001. Yaba now has two patents now lodged and is focused on various milestones set by its investors.

In March 2002, Intrallect completed a second round of funding that secured £420,000. A broad base of investors includes a public scheme, ETF, venture capitalists WL Ventures, a private business angel and private equity from the founders. The consequence of this investment is adding two new investors to the non-executive board.

The current status of DILAB in maintaining its position within the university and seeking a large customer, has resulted in the company not seeking further investment because as John states, they cannot justify it and do not need it at the moment.

9.3.3.3 Management Team

A common characteristic of each case company has been growing their management team because of limitations in the founder(s) skill-set. This ability of young companies and their founders to identify, seek and secure new human resources is identified in the literature as a key factor in successful growth and its absence a common characteristic of start-up failures (Johannisson 2000; Bhidé 2000).

The majority of those interviewed identified that this 'team-building' skill was a highly critical part of the entrepreneur's craft. In essence, this could be seen as a necessary part of them making their business 'vision' a commercial reality. As identified in previous sections, it was mostly left to the founders to conduct the initial identification of market opportunities, negotiate ownership of their technology and secure investment.

Peter of ExpressOn states that he realised early on that his academic background would require a new set of business skills. He suggests that this has been attained by a combination of hands-on mentoring from Adam Christie, ExpressOn's acquired Commercial Director, and his active participation in programs like Connect. Peter states that these learning environments have been critical for Eleanor and himself, but adds that they both are keen to balance their science and business skills. In fact, Peter states that selling the product is difficult for him, partly due to his shyness but running a business has not proved to be difficult.

Similar to ExpressOn, other university spin-outs have brought in experienced senior commercial managers to assist in running a growing commercial venture. Particularly when private investment was involved, a caveat for investment is the addition of business personnel.

One of the criticisms levelled at Intrallect when seeking investment was the lack of a seasoned management team that had taken a new company through formation and growth to exit. Without funds to hire a full-time CEO, Intrallect was seeking

someone to take an equity position, eventually being introduced by their lawyers to Fergus Duncan who took on the role as Intrallect's Chairman. Fergus founded Libra Syscom Ltd in 1994 and as managing director developed it into a successful software company employing 40 people. He exited by trade sale in 1999 and began a role as a business angel and hands-on mentor.

Intrallect also attracted a Non-Executive Director and Financial controller, Graham Bucknall, who provided international marketing experience to Intrallect. He is former CEO of TrustNet, the financial services website and previously set up an Australasian division of a global information and software company, leading it from start-up to exit. He spent his early career in corporate finance with Dresdener Kleinwort Benson, raising over \$1 billion of finance for UK plc's.

Yaba has brought on two experienced managers and grown from a one-person operation in 1997 to 6 staff, 4 of which are scientists. Yaba has put in place a Board and found through Connect a Non Executive Chairman who is well known in UK business circles. Another Non Executive Director has a background in diagnostics but also has a strong financial background.

Since obtaining further investment, AXEON has grown considerably and at present employs 42 people. Hamish Grant has hired a Chief Operating Officer and Chief Technology Officer recruited directly from the University of Aberdeen. Also added to the management team was a Vice President of Corporate Communications, responsible for marketing and market research and a Product Development Manager.

The diversification of founder's roles and activities is also identified in the growth of the company. Indeed, it was typically suggested that even if they were taking on new staff to fill some of the duties, the initial researcher or entrepreneur's time was often solely taken up with one task or another, and as such, other aspects of the business suffered.

Company evolution may also require a re-stimulation of entrepreneurship of an existing company, as seen in the case of Spektra evolving from their management buy-out of a corporate unit to a new technology company. Russell Brodie, Development Director of Spektra, points to the significant difference in attitude between being part of an R&D unit and a new company that required not only new personnel but changes to founders' roles. Spektra's background as an R&D unit had created a company of technologists, but as there was no requirement for commercial expertise, there was no entrepreneurial drive, commercial focus or expectation for such activity. As Schindler money tapered off, Spektra became more accountable for its own actions with a new focus on cash generation, making it essential to expand sales activities. Some people's skills, abilities and attitudes were therefore not compatible with the need by Spektra to change how it did business in order to create a new and dynamic market presence.

In hindsight, if there was a chance to do it all again, Euan suggest that the company would have identified where the weaknesses were earlier and brought on people straight away. This was because Spektra was a very attractive proposition at that point; therefore a professional sales team would have made a difference. Euan was also originally a technologist; he had done an MBA that provided new skills for his new responsibilities. Euan, as Technical Sales Director, has moved from being a technologist to heading the sales and marketing team.

Spektra's other directors have evolved in their roles. Russell, as Development Director, is responsible for ensuring that fulfilment happens, and spends considerable time on recruitment. His position has become more removed from core technology activities, i.e. developing code, cutting code, carrying out designs etc. He is more focused, as he states, on *“what people do we need, what gaps do we have in our skill sets, what skills should we be looking to train, what kinds of people should we be bringing in, i.e. young graduates, 2+ years of experience”*.

Gordon's role as Managing Director of Spektra has been to continue to provide a high level of financial control and give Spektra “visibility over the horizon” as to the

company's financial situation. Since the MBO, he has become more responsible for key financial decisions requiring revenue generation as Schindler payments ceased. This required Gordon to pass on "knowledge" to the other directors, i.e. cash flow, amount in the bank, amount in our pipeline, burn rate, graph to show when we go bust, etc. Gordon's role was to ensure that Spektra had the financing, was taking people on at the right rate etc.

This level of financial knowledge was critically important, because Spektra has no external equity being released. The founding directors and employees own Spektra.

Despite the success of securing new management by the case companies, most identified that considerable time and effort was taken to find and attract qualified new people. One problem is the limited number of experienced managers in Scotland that have seen technology companies through to a successful exit.

Another problem, identified by Spektra, is the lack of qualified technical personnel in Scotland and the expense of hiring outside consultants to conduct personnel searches. This issue will be further examined in the next section.

9.3.4 Recommendations to Improve Support for New Technology Companies in Scotland

Case companies forwarded their opinions regarding improvements to the supportive environment in Scotland for technology entrepreneurship. More specific recommendations for Connect based on their experiences will be described in section 9.4.2.

9.3.4.1 Registry for Technology Excellence

Russell stresses that Scotland requires a register for technology excellence, arguing that recruitment costs are one of the most difficult challenges for new technology firms. He suggests the Recruitment industry is worth £15 billion per annum, so there would be resistance to setting up a national software skills registry in Scotland.

A current yet temporary advantage for Spektra, according to Russell, is that barriers to other local companies competing against Spektra are high. Bringing good people together at Spektra acts as a magnet for attracting and recruiting more good people, and this, he says, builds up something that is a compelling proposition. Spektra is actively involved with Scottish universities; offering project prizes and making presentations to fourth-year computer science students. Spektra is the only Sun Systems Authorised Java Centre in Scotland and is attractive to potential employees by providing opportunities to gain certified skills and to work on leading edge technologies, dot.com development and business-to-business e-commerce development. Spektra feels that potential candidates for positions will not find opportunities like that anywhere else in the UK other than London.

However, a key challenge for Spektra as a rapidly growing company is securing a wide range of qualified human resources, driven by its commitment to recruit and train the best team of Java architects in the UK. Russell again argues that growing a workforce is very expensive and gaining access to a recruitment agency's database

costs almost £5000 per person, so a major growth of 50 people costs £250,000 just to find them. In hindsight, back in Oct/November 1999, Spektra would have recruited as many object technology people with the right attitude and right commercial awareness it could have if it had the funds. Coming into 2000, there are a number of other big start-ups that are attracting these people with big budgets, thus elevating the rates in the market.

Similarly, Yaba sees the cost of professional services as a major restriction for a new company, as it takes up a huge percentage of limited available money. Gareth suggests that one scheme that was attempted in Scotland should be attempted again. One group tried to get on board a number of well-respected professional service companies, in areas of accountancy, law, patents and copyright, etc. This group aspired to provide these services at knock-down rates for start-up companies on the premise that if the companies became a going concern, they would remain as their professional service provider. Gareth suggests that this would be a very effective approach, but the group failed to get funding to follow up on the concept.

Russell suggests that the technology is there to develop this free database; it's finding the necessary compelling reason to get people to register. Technology skills could be registered on a central database so that people wherever they may be, can go and browse candidates' details and information freely without having to pay a significant sum to do that. By clicking on a candidate and through a controlled disclosure mechanism they can chose to investigate further. Information would be through a standardised CV format.

Russell sees this being set up with a credible body like Connect or the Scottish Software Federation. The difficulty, Russell says, is in compelling people to put their details into this registry; one must find the correct psychological lure to fill in the details. He suggests that it could start by going to technology courses at universities and getting students to fill in their details and receive an Amazon voucher. By offering an e-mail address that goes with them wherever they go, one could forever contact those people. It is then up to the individual companies to

create the environment and the attractions to stay with that company, as people can register details anonymously and compete within the software market.

Through marketing and cultivation efforts, one could build-up a census of technology skills in Scotland. Russell concedes that the problem is that skills are quite dynamic but believes that the benefit to business in Scotland in 5 years time would be colossal. He emphasises that this should be a free resource to all the technology companies in Scotland.

9.3.4.2 Registry for Mentors and Directors

Case companies identify that finding good directors is highly subjective, prone to errors in judgement and costly for new entrepreneurs and companies. They suggest that Connect could assemble a list of potential directors and board members for different sectors so that a company could go to them. This would allow new entrepreneurs to tap into solid business experiences for useful advice and direction. Connect could also facilitate those wanting to act as mentors.

9.3.4.3 Database of Potential Investors

Gareth of Yaba points out that there is a requirement for a neutral company that can develop a database of different financial investors in Scotland. This database would include what these providers invest in and the level of funding they provide. This would allow emerging new technologies to come along and chose those more relevant investors. Seeking of financing has been much more of an *ad hoc* process than Yaba had anticipated. Scott has gone to the US, Germany and throughout the UK to seek financing. This kind of approach takes time, and for a small company like Yaba that is financed by loans, it is risky, because of their payment requirements.

Gareth suggests that perhaps Connect, perceived by many in Scotland as a neutral body, could develop a list of potential investors and ask each potential investor to describe what they are interested in, and possibly give a list of the companies that they have invested in. This would enable companies to make the appropriate approaches.

This more proactive role for Connect would be to provide companies with the names of people that would be interested in their specific technology, with Connect playing a role in brokering informal meetings at a Connect event. As Scott notes, it is not feasible to go through the front door of VCs, as you are just another business plan. He also suggests leveraging the Connect network beyond Scotland, i.e. investors in San Diego and other parts of Europe.

9.3.4.4 Export Support

One support gap identified by Yaba regards exporting opportunities. Scott suggests that missing in advice to date is someone actually listening long enough to understand the product and provide information on appropriate markets and explain the means available and processes to do it. Critical to this knowledge is who the right people are, and strategic options if one strategy is not viable. Scott and Gareth point out that, for their business, this type of service is not readily available in Scotland.

Although generic information is available, it is the higher level of information that is missing. The key question Yaba asked is *'how does a company get round the obstacles in the export business'*? Although Yaba has had contact with a number of supportive agencies, their request for specific information was beyond the area of expertise.

Gareth and Scott suggest that this information is critical, as it saves valuable time and money if the company immediately knows that it has to consider alternative ways to

enter the market; i.e. getting a domestic company to manufacture the kits and sell them under a license. As an example Yaba found out from laboratories in the US that they couldn't export into the US, but had initially been led to believe from a source in the UK that they didn't need an export license to do so. As Gareth states: *"If Yaba had know that 6 months ago, they would not have wasted time and money."*

9.3.4.5 Ongoing Training Programs

The challenge for Spektra, according to Russell, is to be leading edge in a highly competitive and dynamic sector, with the company committed to continually benchmarking its skills against the highest industry standards. This involves keeping an eye on what is coming from the USA. A key challenge is ensuring that their staff get the right training and personal development that they require. As there are very lucrative contracts out there to be delivered on, Spektra has to be clever on how they make sure that people are still developing their skills and not being thrown into situations that are beyond them.

Russell states: *"My challenge at the moment is to find enough training companies who are prepared to provide training that is convenient to the company and client rather than to the training company"*. A one-week course is not convenient or viable. Russell points out that training programmes *per se* don't really exist. The company has had to be creative; i.e. have developed breakfast training sessions using local training companies, starting at 8:15am, providing breakfast, and finishing at 10 am, once a week for 8 weeks. This enables people to retain control of their commercial projects but provides this slightly fun element of training for their development.

9.4

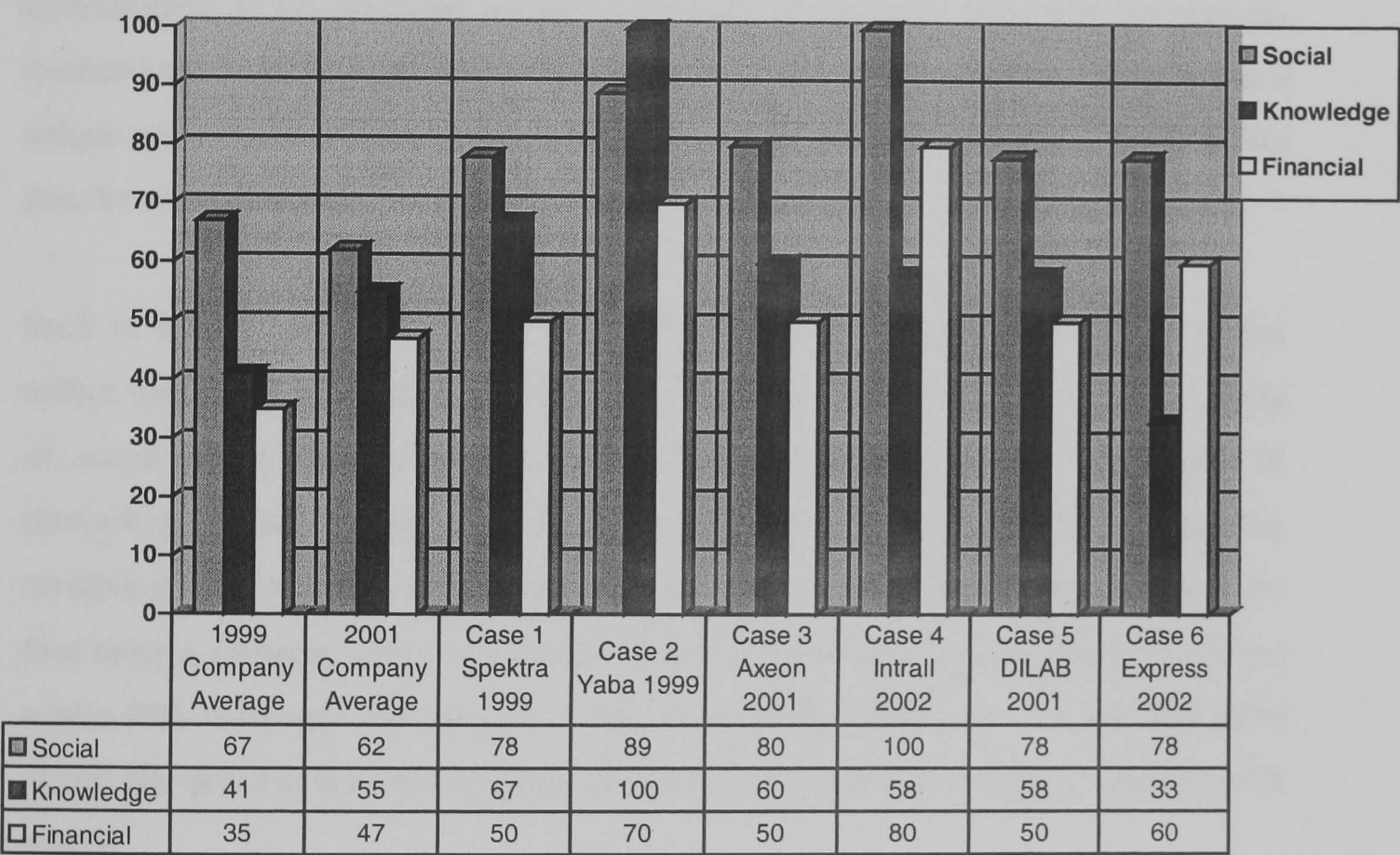
DISCUSSION AND SUMMARY

9.4.1

Value of Connect for Case Companies

Graph 9.1 shows that all six case companies rated social value as most important and significantly higher than 1999 and 2001 survey averages. Although knowledge value for all companies was rated higher than survey averages, two of six companies rated financial value significantly higher than knowledge value.

Graph 9.1: Social, Knowledge and Financial Value of Case Companies



Graph 9.1 shows significant variation in levels of social, knowledge and financial value perceptions among case companies, demonstrating how network relevance depends on evolving needs of companies and their founders when measured at different points in time. For a new network member company like Yaba, its two directors identify Connect as the company’s most important support program. Affirmative responses to all social and knowledge indicators and three of six financial indicators suggest a ‘significant’ value curve for both Gareth and Scott as these two ‘new’ entrepreneurs form their company.

Connect's value to Intrallect has been in providing its academic entrepreneurs with commercial contact to form their business and meet investors and develop commercial business skills, particularly for Dr. Peter Douglas, who was primarily responsible for forming the company. Intrallect directors rated technology knowledge value lower, primarily because the company is highly focused on moving its fully developed middleware and e-learning tools to new applications for export markets.

Similar to Intrallect's responses, DILAB's Professor John Wilson rates the knowledge from business-focused event topics more important than learning of new technologies, as his diamond-coating technology is unique in Scotland, limiting his interest in technology topics available through Connect. ExpressOn similarly has a unique antisense technology and rates social and financial value significantly higher than knowledge value.

Each of Spectra's three directors rate knowledge value perceptions differently that reflect individual needs and benefits. However, they were consistent in their rating of social value that reflected their shared perceptions of the importance of networking for the company. Euan Robertson explains that the process of gaining credibility for the new company was all important: *"This relates to the fact that the first thing a company does is go to the lawyer to write up legal contracts to protect assets IPR, then asks the lawyers, "who should I be talking to". From this point begins the process for the company of building a reputation through contacts with others"*.

A common theme among all case companies is the value of Connect particularly in the early stage development of their companies. Euan Robertson of Spektra commented that Connect was the most appropriate support group for the company earlier on: *"Connect had the right players in it; had the like mindedness and was buoyant and positive with a "we can do it" attitude. Connect's speakers were entrepreneurs who had been there and done it, and events were focused"*.

Companies identify the role of Connect in helping to allay some of the difficulties faced in the search for investment. By immersing themselves within the network, those interviewed suggested that this environment provided them with a solid business-like basis for understanding, in realistic terms, what they could achieve, whom they should approach and what they could expect in terms of possible investment options.

Hamish Grant of AXEON explains that Connect has been most useful support group, with particular relevance to the problems faced with raising finance, with Ian McDonald in particular proving to be of great value. Hamish states: *"We presented at both the '98 and '99 Connect Investment Conferences. Those conferences gave us a platform on which to advise ourselves [about where they thought they might be going wrong]. The meetings proved to be a very good networking environment and indeed [Connect CEO] Ian McDonald himself was a very good person who had a good source of contacts"*

Spektra's Managing Director Gordon Stuart praises Connect's role in developing angel investors with a 'technology bias' and in providing knowledge dissemination to institutional investors. These efforts, Gordon argues can be seen in the growth in software investment in Scotland by angels active in Connect (e.g. Ian Ritchie, Martin Ritchie, Andy Davis). The challenge for Connect and others should remain focused on "championing the realisation of value in existing small firms and helping grow new firms" Gordon states.

Another way Connect is making a difference regarding investment, according to Gordon, is in changing attitudes to equity. He states that entrepreneurs are realising that a small percentage of a big pie, with the right people moving it forward, is more valuable than a large percentage of a small pie where value has yet to be added by others.

9.4.2 Specific Recommendations for Connect

9.4.2.1 ‘Staying the Course’

Hamish suggests that Connect “*have served their purpose admirably*” and are ‘outgrowing Connect now that AXEON is no longer a ‘new’ company. With this assertion, Hamish cautions that Connect should be wary of “overstepping their current boundaries of expertise”. He adds that by concentrating on, and possibly increasing, what it does best – more networking programs and getting better at attracting people to networking programs – Connect’s value can be enhanced. In summary, it was felt that Connect’s main value was in the delivery of quality social networking opportunities, the facilitation of knowledge flows and the increased exposure to potential financiers.

9.4.2.2 Flow Through and Recruitment of Members

Gordon of Spektra asserts that a key challenge for Connect is to define more clearly whom they cater to. Gordon states that he has personally ‘plateaued’ in terms of benefits derived from Connect, noting that things are all new at the outset so new entrepreneurs benefit most from Connect but the rate of learning eventually slows down. Connect thus needs to encourage new people to come along to events, as Connect shouldn’t be for established firms; the purpose for Connect is to “*get you going*”. Gordon hopes that in time he will be able to contribute to helping others through Connect.

9.4.2.3 Event Relevance for Stakeholders

An identified concern expressed by some case company respondents - also identified in survey findings - is the expectation that Connect must be relevant to a broad cross-section of technology sectors and stakeholders. For example, Russell of Spektra notes that Connect was most appropriate for their senior people, but not necessarily

for the technology-focused staff, as they simply wanted to find out about what was new in technology nitty-gritty details.

However, other companies, such as ExpressOn and Intrallect, argue that scientists in spin-out companies require commercial knowledge and skills in addition to maintaining their technological expertise and keeping in touch with recent developments. As such, the social aspect of Connect events are considered, not just a *'hub for people to exchange ideas'* but also a forum where people can access business experience and knowledge outside their immediate business setting that is friendly and informal.

For some sponsors and other stakeholders, too much of a technical orientation at events is not welcomed, as one respondent in the 2001 value survey states: *"some events tend to be a little bit too much academically focused"*. As well, some respondents suggest that there was a slight imbalance in member backgrounds with a general bias in the culture towards investment and business interests focused on opto-electronics and other IT interests. Indeed, it was expressed that the *"biotechnologists who are looking to start companies are feeling like second-class citizens"*.

9.4.3 Summary of Connect's Benefits to Case Companies

- ◆ Connect is perceived as a valuable forum most relevant during early formative years of the companies:
- ◆ Connect is highly relevant for individuals requiring business-related skills and advice, thus facilitating the "learning curve" particularly for academic entrepreneurs with limited commercialisation experience;
- ◆ The informality of events sets the correct tone for its members. The social aspect of Connect's events are considered, not just a *'hub for people to exchange ideas'* but also a place where people can gain crucial business experience and

knowledge outside the immediate confines of their own business in a relaxed and informal environment;

- ◆ The informal atmosphere of Connect's meetings also fosters new ideas or applications to be derived from potential clients; and
- ◆ Connect opens a channel to speak to other sectors and helps to expose business to new market in a 'non-threatening' manner.

Connect's value for case companies are seen at two levels; at the 'personal level' where entrepreneurs wished to create increased opportunities to network at particular events. Here, Connect acts as a 'guide' in finding the right people and the right kinds of recommendations.

At the second level, a 'development level', companies gained opportunities to gain legitimacy and reputation, search for investors, partners and service providers as well as searching for new management personnel, directors and other suitable human resources.

Case study findings confirm the importance of a particular range of '*intangible benefits*' derived from the Connect network. Even though different technological capabilities are centrally important to each company, social capital as a common intangible benefit allowed companies to identify and secure necessary complementary resources. Connect also accelerates the 'learning process' for new business skills and knowledge particularly for academic entrepreneurs. The '*meet the entrepreneur*' event, for example, was credited for its provision of valuable insights into 'trial-and-error' issues that founders were experiencing at the time.

CHAPTER TEN

COMPLEMENTARY SUPPORT INITIATIVES AND CONNECT

10.1 INTRODUCTION

This chapter describes complementary support initiatives and the role of Connect amongst these initiatives that first examines Scotland's support environment for technology entrepreneurship and relevant initiatives identified by Connect's company members. They include Scottish Enterprise programs, university technology transfer offices, Edinburgh Technology Fund (ETF), Scottish Institute for Enterprise (SIE), the Entrepreneurial Exchange and Global Connect¹.

The role of universities in supporting technology entrepreneurship is further examined along with perspectives from one of Scotland's most high-profile research institutes - the Roslin Institute – on how they exploit their science and their views on the support environment in Scotland. Connect's role amongst these complementary initiatives is then examined followed by a chapter discussion and summary.

10.2 MULTIPLE SUPPORT INITIATIVES IN SCOTLAND

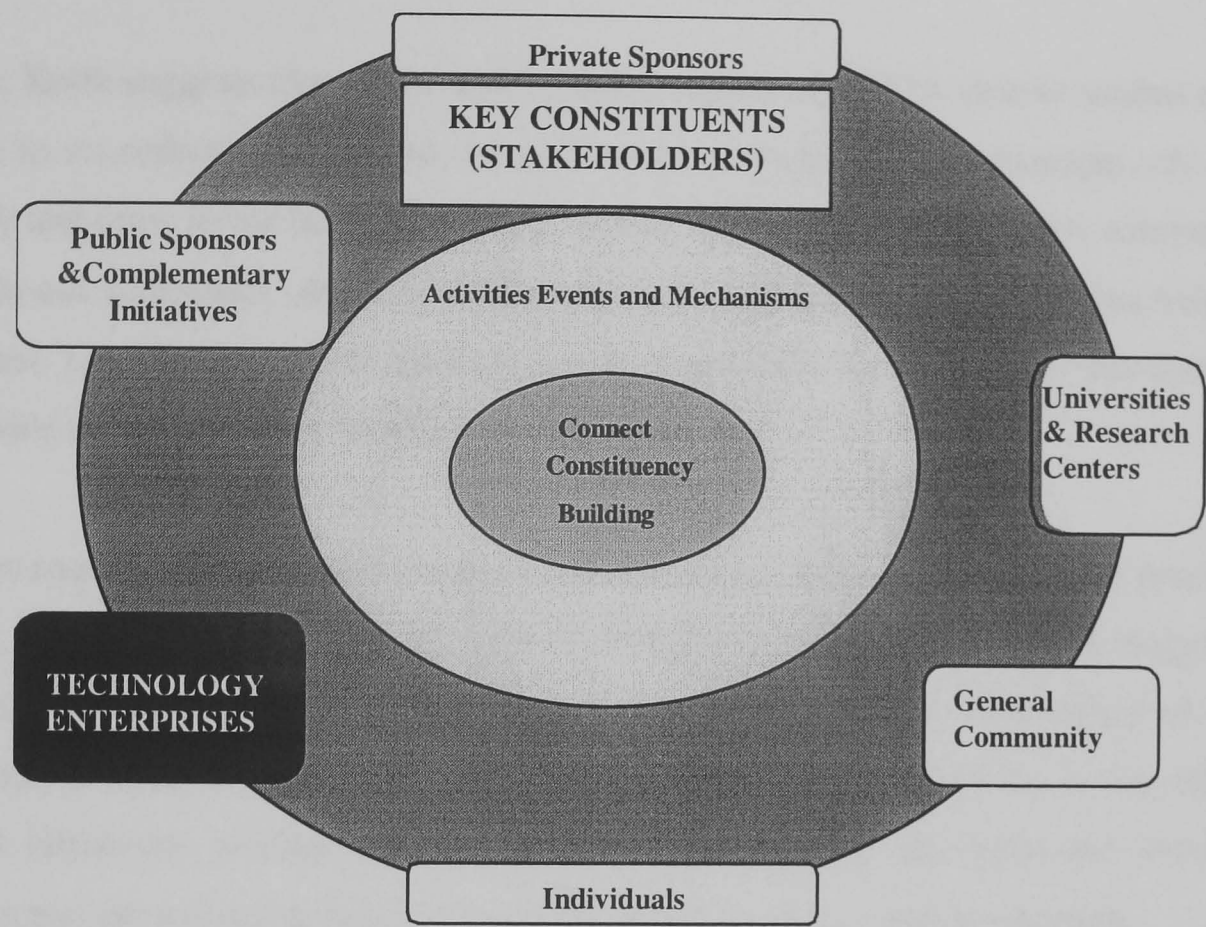
Complementary support initiatives, along with sponsors, universities and research centres, individuals and the wider community, make up the multi-stakeholder constituency of Connect whose objective is to support new technology enterprises in Scotland (Figure 10.1).

As a result, multiple *points of access* for entrepreneurs and technology companies are available among this support constituency. Points of access include university technology transfer offices, local enterprise companies (LECs) of Scottish Enterprise,

¹ The ETF and Scottish Enterprise Proof-of-Concept Fund have been examined in detail as described in Appendix I.

Technologies Ventures Scotland, Scottish Institute for Enterprise (SIE), and various technology-specific agencies.

Figure 10.1: Key Constituents (Stakeholders) of Connect Scotland



The extent of this supportive ‘landscape’ creates confusion for entrepreneurs and new technology companies, according to some Connect stakeholders. Dr. Keith Winton, the Director of the Edinburgh Technology Fund (ETF) argues that there are too many steps for assistance and many points of entry for new start-ups in Scotland. Keith states that he is unclear how Connect fits with other support initiatives, such as Technology Ventures Scotland and Scottish Enterprise. He indicates that multiple support programs that seem to be doing similar things ‘*muddies the water*’ and creates confusion for not only potential entrepreneurs and academics but also for the agencies themselves.

For example, Scottish Enterprise's LINC² (local investment networking company) is itself a nation-wide, not-for-profit, business introduction network or "marriage bureau" for companies and investors. LINC is also supported by a wide range of public and private sector sponsors with a mandate to offer an independent and impartial service as facilitators rather than investment advisors.

Ideally, Keith suggests that a new technology company should be able to contact one agency to co-ordinate things and act as account manager, project manager, etc. to identify and draw in the necessary resources and requirements for the new company. For spin-out companies, this role would allow the academic to focus on what he/she does best, i.e. focus on the technology development, and Keith suggests this should be the role of the university technology transfer office.

For non-academics attempting to start a new company, Keith argues that the process is even more difficult. Within the Scottish Enterprise network itself, Keith suggests there is significant variability in the quality of services and no consistency in the brand across Scotland. He adds that a consequence of this variability is that other support initiatives, perhaps Connect among others, take up the slack and provide services that are not being fulfilled by other initiatives with a similar mandate.

Hamish Grant of AXEON sees a problem with the credibility and background of public support advisors, stating that too many support programmes are filled with "*low-grade consultants and low-grade civil servants*" that are not entrepreneurial themselves and consequently do not really understand the actual needs of entrepreneurs. Hamish suggests that Connect takes a different approach to 'support' and avoids many of these problems. This point will be further discussed in section 10.6.

Hamish further argues that the Scottish government and in particular, Scottish Enterprise³, typically introduce a lot of well-meaning programs that at first sight may

² LINC acts as an intermediary between investor members interested in investing in technology based businesses and prospective new companies seeking investment in an attempt to achieve a 'good fit' (<http://www.lincscot.co.uk>).

³ Scottish Enterprise (SE) is the Scottish government's official economic support agency and provides a myriad of support schemes, programs and projects for all forms of business activity.

seem useful but in reality are often very poorly considered and implemented. He points out the recent demise of the 'Scottish Birth Rate Strategy' as an example. Hamish goes on to suggest that a problem with some of these programs is the administrative burden of applying to the grants that they administer. Hamish suggests that the average entrepreneur simply cannot be bothered to apply and states: *"It seems that you must not start working on a project before you have been awarded a grant, but then it can take six to eight months to get the grant in the first place, that is simply not what is helpful to us"*.

At the same time, the existence of the Scottish Enterprise program, Keith Winter suggests, is looked upon jealously by those in other parts of the UK. The English scene is highly fragmented without the same level of assistance but Keith also concedes that this may only be because Scotland is such a small region in comparison to England and easier to co-ordinate.

One major problem with public support initiatives is the combination of broad objectives and how 'success' is gauged and measured, according to Connect CEO Ian MacDonald. Literature identifies measurement and evaluation as a common evaluation pitfall for *public* support programs (Patton 1990) and in particular choosing appropriate performance measurements and implementing them.

Ian suggests that many public support programs use simple quantitative measures, one being the 'number of companies that are offered assistance'. A problem with this measure, according to Ian, is that numerous programs may take credit for the performance of a particular company receiving support. Thus the quality or value of support provided is not assessed.

A related problem regarding public initiatives is launching new public sector support that may replace or duplicate initiatives already in existence. Connect Director Andrew McNair states his concern regarding resource take-up of public programs as they attempt to add new programs and services. Similarly Connect CEO Ian MacDonald expresses frustration that some public organisations are taking credit for

what Connect is doing, and that public funds are being directed to provide duplicate, rather than complementary programs.

Ian points out that the Connect network – built on public and private investment – has been developed over a 6 year period to a point now where considerable value is available within the network for new technology companies. The fact that some Scottish support initiatives have not worked and been discarded, such as the Scottish Birth Rate Strategy, is another factor in Connect's favour and highlights Connect's value, Ian argues.

The real issue for all support programs, according to Ian, is to *demonstrate* value. The issue of value by stakeholders is critical, according to Ian, in distinguishing Connect from other support programs, but he concedes that the key challenge remains in actually showing people the value of Connect, why it is different to other initiatives around and why companies and sponsors should get involved.

10.3 RELEVANT COMPLEMENTARY INITIATIVES

10.3.1 Scottish Enterprise

All four university spin-out cases described in Chapter Nine received SMART⁴ awards administered by Scottish Executive's Enterprise and Life-long Learning Department. The stage-one award is a competitive award and provided Intrallect to carry out a market feasibility study lasting 6-18 months. Successful completion of stage-one – completing stated milestones – allowed DILAB and Intrallect to secure a non-competitive stage-two award designed to assist with the development of a pre-production prototype.

⁴ Key criteria for SMART is an R&D project leading to introduction of new products/processes. Projects must be highly innovative in a technical sense (i.e. a 'first' for the UK or sector concerned), and be commercially and financially viable. There is no limit to the number of companies funded; 37 companies received awards in 2001.

Another important seed scheme identified by the case companies was the Proof-of-Concept Fund (POC)⁵ administered through Scottish Enterprise. POC was created to address a perceived pre-seed funding gap restricting the flow of technology from university laboratories to the marketplace. Being a relatively recent initiative, it was not identified in case studies. However, Connect Director Andrew McNair suggests that the Proof-of-Concept fund is providing the momentum for change regarding university commercialisation. A limitation of POC is that it provides funds directly to the university to support basic research in developing a prototype of basis for a marketable product. Although it is hoped that new company formation will result, it is not a prerequisite for successful receipt of the fund.

In addition to the Scottish Enterprise investment schemes, case companies identified specific people from the agency whose assistance was attributed to achieving milestones particularly during company formation. These advisors assisted Yaba with due diligence and licensing negotiations with a Danish technology company, helped Intrallect in winning the SE “who wants to be an entrepreneur award”, and assisted ExpressOn in securing investment. These advisors are normally based within one of Scottish Enterprise’s 12 local enterprise companies (LECs) that provide general start-up support and advice throughout Scotland.

10.3.2 Edinburgh Technology Fund

In addition to SMART awards, Edinburgh-based case companies Intrallect, Yaba and ExpressOn secured support from the Edinburgh Technology Fund⁶ (ETF). Unlike the POC fund, ETF Director Dr. Keith Winton explains that the ETF can put funds immediately into a new company and is much more commercially focused. The ETF fund of approximately £2 million is intended as grant funding rather than realising

⁵ The POC fund was launched in 1999 as a three-year, £11m fund that has grown to £33 in 2002 to cover the next six years. As of 2002, the POC fund has supported 83 projects that SE suggests reflects a combined market value of £13m and 207 new jobs.

⁶ The ETF is part of Chancellor Gordon Brown’s University Challenge Fund announced in 1997 to provide seed-corn funds for university-generated science and technology ideas for commercialisation. The ETF involves the University of Edinburgh and a number of its associated research institutes that include the Roslin Institute, Mordun Institute and a number of other public research institutes. Glasgow-based spin-outs have access to their own similar fund.

returns on investment but can also be used as equity funding to eventually keep the fund sustainable.

Unfortunately, ETF and Proof-of-Concept initiatives emerged at approximately the same time from different sources with no co-ordinated strategy, according to Keith. One of the problems that both POC and ETF faces, he explains, is the assumption that seed funding can proceed without identifying subsequent investment possibilities at the same time.

Keith explains that the “*real objective of the seed funding is getting people onto the ‘latter’ and generating investor credibility or awareness to facilitate a next stage of private investment*”. But the economic situation has changed that progression. In fact, he suggests that he would not create the same model of the ETF today because getting the next round of funding is a key challenge for new companies. Keith suggests that this gap is recognised by Scottish Enterprise and other initiatives such as the *Co-investment Scheme* between public and private investors but more needs to be done. Findings from the case studies support Keith’s assertion, as all but one of the six companies identified a significant gap between seed funding and subsequent investment.

The true objective of ETF, Keith explains, is to provide an assessment level fund to determine if there is a market opportunity. Keith describes it this way: “*a few thousand pounds to do a ceiling, wax and string demonstrator in the lab...if that seems to work, ETF may put in development money and then the next stage would be commercialisation – possibly a larger amount of money as the opportunity progresses successfully*”. The sum total cannot be more than £250,000.

Keith explains that the primary benefit of ETF is to promote the commercial seriousness of a new company. This is accomplished by keeping the financial records and providing initial corporate governance, allowing Keith to actually close the company down rather than allow the company to go insolvent. Keith in essence

assists the company by setting up, as he calls it, “*a vehicle with a commercial shell that divorces the company from the research environment*”.

Keith has reviewed over 300 business proposals in the last 3 years and ETF has supported 50. None of these companies to date have realised returns to ETF as of June 2002. Almost one-third are biotechnology and life science, a third are electronics and software and the remainder include companies from chemistry, engineering and social sciences and consulting.

Both Ian and Andrew of Connect identify the POC fund and ETF as key complementary initiatives for Connect in that they provide ‘deal-flow’ into Connect. In other words, companies with these awards have already undergone initial scrutiny of their technologies that have been identified to have high commercial potential. Connect’s value focuses more on the commercial value needed to form and grow a company, seen in the social capital, knowledge flows and investment opportunities attributed to Connect by company members.

10.3.3 The Scottish Institute for Enterprise (SIE)

Other initiatives are identified as having direct relevance with Connect in addition to ‘deal-flow’ initiatives promoting new company formation. The Scottish Institute for Enterprise (SIE) is focused on nurturing the next generation of entrepreneurs in Scotland. As identified in the case studies, entrepreneurial vision, initiative and persistence, among other traits, were key drivers in not only forming new companies, but in overcoming a myriad of technological and commercial obstacles. SIE Director Carl Togneri explains that Connect and SIE are continuing to formulate a working relationship to provide entrepreneurial content and support initiatives for science students at universities in Scotland.

Professor John Wilson of DILAB provides another view of the SIE initiative. He suggests that initiatives to promote entrepreneurship at UK universities will be

beneficial to those students that have an interest, but he states that “*it is difficult to ‘make’ entrepreneurs*”. It is important to demonstrate to students what is possible and provide the message that ‘entrepreneurship is not so much of a *‘black art’* but John concedes it is difficult to know how much impact promoting entrepreneurship will make on economic life in Scotland.

10.3.4 The Entrepreneurial Exchange

Connect directors identify the Entrepreneurial Exchange as a possible ‘next step’ forum for technology companies as they successfully develop as a going concern. The Entrepreneurial Exchange’s mission is to “make Scotland a more entrepreneurial and confident society” and calls itself “Scotland's leading members' organisation for ambitious, growth-orientated entrepreneurs”. Formed in 1995, it claims 400 members, representing over £6 billion of turnover and 88,000 employees.

Connect CEO Ian MacDonald suggests that the Entrepreneurial Exchange would be a threat to Connect’s role if they decide to develop a similar network model. As Andrew McNair states, “*they have more clout with Scottish Executive and Scottish Enterprise than Connect*” and companies and indeed sponsors, cannot afford to be members of various organisations and support programs.

However, the Exchange is more focused on successful entrepreneurs and companies and does not appear to share the same mandate as Connect at this time. Indeed, survey findings confirm that Connect is most appropriate for young technology companies, providing a relevant forum and contact point from which social, knowledge and financial benefits are realised to varying degrees.

The diminishing relevance of Connect for companies as they successfully form and grow would suggest that the Entrepreneurial Exchange may be one of those different communities and more focused networks (Birley 1985) available for Connect

‘graduates’ as they seek appropriate new social contacts and business-related resources.

10.3.5 Global Connect

A broader complementary initiative is the Connect Global Alliance⁷, a consortium of all Connects around the globe that have originated from the Connect San Diego model started in 1985. Currently there are 14 Connect programs, and discussions are underway to develop a global alliance of these Connects by leveraging their common philosophy of networked support to promote and showcase technologies among stakeholders of the alliance.

A further opportunity for Connect Scotland is providing an educational forum to promote the benefits and features of the Connect model to other regions around the globe⁸. This opportunity has arisen in response to a request from Connect San Diego, who has experienced significant interest in recent years from other regions interested in adopting the Connect model. Connect San Diego was finding that a high level of staff resources was being devoted to answering requests for information, meeting with interested parties and organising visits and workshops.

10.4 ROLE OF UNIVERSITIES

The commercial role played by universities in enabling (and constraining) spin-out companies and the weaknesses of university-industry linkages is prominent in the case study and survey findings.

⁷ Global Connect includes 5 US-based programs, 4 in Sweden, 2 in England and one in each of Norway, Denmark and Scotland.

⁸ Connect Scotland has agreed to assist in providing formal educational forums to discuss the Connect philosophy and operations. Connect will provide four two-day workshops to overview Connect. On an annual basis, two will be held in San Diego and two will be held in Europe.

The directors of Scotland's two largest technology transfer offices, Dr. Bob Smailes of Edinburgh University and Dr. Cathy Garner of Glasgow University, identify the high expectations by their universities is realising commercial returns on generated innovations and technologies. Their high volumes of research are expected to produce increasing levels of value that provides immediate or near-term returns rather than medium to long-term returns. Indeed the notion of risk is a strong consideration for technology transfer decision-making.

Therefore, increasing benchmarks with similar universities, competitive pressures and the more recent inclusion of AUTM (Association of University Technology Managers) figures for comparison purposes creates institutional inertia to continually increase research returns. The role of the spin-out company, although clearly identified as an annual target, is much higher risk and much more difficult for technology transfer personnel to deal with because of the intangible variables and commercialisation considerations.

Gordon McAndrew, Chairman of Venture capital firm West Lothian Ventures and a former chairman of Connect's working group in Dundee, identifies a number of issues and challenges in exploiting university technologies. Gordon is one of Scotland's most respected business advisors and has been involved in doing technology spin outs and technology start ups for nearly 20 years.

Gordon has watched with interest the emergence of large technology transfer offices, particularly at Edinburgh and Glasgow universities. He suggests that some technologies created within universities may have markets that are world-wide and often the only way to reach them is through existing channels that require a degree of power and critical mass found in a large technology transfer office. He cites the example of strong relationships required for medical diagnostics with leading distributors such as Hammonds and Roche. These companies have the routes to market and the credibility with not just the NHS in the UK but with American private health.

In addition to providing routes to market and assisting inventors with commercialisation strategies, such as licensing or selling to a company with already established channels or spinning out, Gordon sees technology transfer offices providing the necessary processes, such as IPR protection, licensing agreements, etc. that prepare the innovation for exposure to these channels and networks.

However, Gordon cautions that technology transfer will suit some commercial situations but not all. For a young company to try to break into world markets no matter how innovative and advanced and good its technology is, it will find it an uphill struggle, Gordon explains.

A key hurdle initially in the commercialisation process, according to Gordon, is that someone has got an idea but doesn't know what to do with it. He cites the example of Axis Shield, a Dundee University biotechnology spin out that began in the basement of Ninewells Hospital in 1982 and now employs over 400 people and is listed on the London Stock Exchange. Gordon got involved with Axis Shield from the beginning, after the inventors had gone into the Tayside Regions Industrial Office who recommended that they talk to Gordon because of his business experience.

Gordon's experience with Axis Shield and other university spin-outs highlights to him the naivety and the inexperience of the commercial world and commercial realities that lie within the university sector and the difficulties of spin out for very intelligent, technically-focused people.

Gordon stresses that there is a very significant need, there in 1982 and still today, to provide a catalyst to this subset of university technologists and certain others who wish to spin out. Although those expected to manage a spin-out business often have excellent technological ideas, Gordon points out that they have been brought up in a university society which in general is not just ignorant but sometimes hostile to the commercial world.

ETF Director Dr. Keith Winton shares some of Gordon's concerns regarding the role of university technology transfer offices. Keith suggests, first of all, that universities are the first port-of-call for any academic scientist or technologist attempting to start up company, since technology transfer offices are official bodies dealing with members of staff. The technology transfer office will eventually become involved at some point, and Keith argues that contacting them early on saves much grief later on when attempting to spin-out and sign over IPR. Case company Intrallect identified this lesson in dealing with Edinburgh University.

Keith argues that a problem for very large research universities such as Edinburgh and Glasgow is the wide range of innovations generated from a number of specialised departments. This makes it difficult for a central single technology transfer office to have all the skills and knowledge to support each area of research.

Keith also feels that spending efforts attempting to turn academics into business people may be futile, as those with entrepreneurial aspirations will follow an opportunity without being pushed. He suggests finding those people with the skills to commercialise the innovations that are partly developed, similar to Gordon's assertion of 'providing a catalyst' to those in the university with excellent ideas.

A further concern for Keith regarding university support for company creation is what he calls *"an enormous scope for conflict of interest in the present structure because technology transfer offices are charged with commercialisation of their university's research – whatever that may be"*. But the technology transfer office also has a role in the management of the technology transfer centre that is effectively there to incubate new companies and provide support.

Keith continues *"if you are in the game of incubating companies then you are very quickly going to be at a point where those companies will need advice on spinning out a company from an independent source...technology transfer offices cannot represent both of these"*. Keith states that academics wanting to spin a company out

are members of the university entitled to a certain level of support that any other member of the university would receive.

Keith therefore argues that there should be a separate entity, possibly even within the university, to act as a *'father figure to the company'*.

The other issue for technology transfer, according to Keith, is the over-emphasis on licensing and the value of IP without understanding that IP is not of much value without the people behind the innovation. Intellectual property within a new company, by contrast, is fundamental to the company's mission and its core activity. *Universities are a 'collection of fiefdoms, each with their own research group interests with little interest in picking up other research if another research group disappears. The university itself cannot actually exploit anything directly in the marketplace, it can only do it through the staff, and if the university staff are not interested in licensing or they leave, the university does not have much of any value'.*

Keith suggests that it is a common fault of many universities to inflate the value of IP, although it must be considered in the context of increasing pressures on universities to generate more income through their commercialisation results. In many cases, Keith argues, this is unfair pressure because it results in "loosing site of why universities exist – universities exist to do basic research and teaching – and the product is a graduate with skills that can be used elsewhere". The commercialisation of research, Keith continues, is important but is a by-product – a third leg – to what universities do, but universities should not be seen as promoters of economic growth, although they are perceived that way because of the research they perform and because of their size. But universities should not be seen as economic growth agencies.

A worrying trend catching on in Scotland, according to Keith is university involvement in science parks and incubators, seen by the most recent *Technopole* project by Edinburgh University. Models for comparison include the Cambridge Science Park and the success of the "Cambridge Phenomenon". Keith points out that

although Cambridge and its colleges initiated the Science Park, companies now go there because of the address and the presence of competitors and not the university. He adds that its operation is quite separate from the university now.

These initiatives, Keith argues, are not the core business of a university, and universities need to concentrate on what they do best. Although there could be a graduating process to the incubator then the Science Park, etc. without actually establishing a preferred route, he suggests that these initiatives should be separate from the university and be left for people that can operate them effectively.

10.5 RESEARCH CENTRES: THE ROSLIN INSTITUTE

Public *research centres* are also stakeholders of Connect but take a somewhat different role in commercialising their research than universities. Dr. John Wither, Roslin's Assistant Director, provides his views on how Roslin exploits its technologies and science base, the role of Roslin with Scottish universities and the challenges facing technology start-ups in Scotland. The Roslin Institute, home to the first cloned mammal '*Dolly the Sheep*' is one of eight research institutes funded by the British BBRC (Biotechnology and Biological Sciences Research Council) and among a number of world-class research centres based in Scotland.

Roslin has strong relationships with a number of Scottish universities but is an associated institute of Edinburgh University⁹ – an official title with no legal standing. Roslin has linkages with 17 UK universities that include many of the Scottish universities and Nottingham, Bristol, Leeds, Liverpool and others in England. These links with other universities are based on links between institutions' scientists rather than any formal linkages with the institutions.

⁹ Historically, Roslin was part of Edinburgh University, from 1917 when it was the Institute of Animal Genetics and was located at the university's Kings Buildings until 1980. A number of senior staff at Roslin hold honorary chairs with the university. One reason, John suggests, for the strong linkage between the two institutions is geographical proximity, with only 7 miles between Roslin and Kings Buildings of Edinburgh University. Most of Roslin's PhD students are registered with Edinburgh University.

Unlike universities, Roslin does not have a separate technology transfer office. John's role is responsible for all non-scientific and business, legal and personnel aspects of the institute and Roslin's annual turnover is £12 million provides justification for a business manager. One of Roslin's drivers to pursuing commercial exploitation, if government policy is set aside, is to survive, John claims. Government funding for agriculture is reducing significantly, as 70% of Roslin's funding traditionally came from the UK's Ministry of Agriculture. Ten years ago, John says that core funding was 90% and in 2002 is down to 24%. Thus exploitation of Roslin's science is a prerequisite for ongoing sustainability in the least.

Although Roslin for many people is synonymous with *Dolly*, John points out that this has overshadowed the other 30 science projects currently ongoing. He suggests that one emerging project has the commercial and financial potential to be far more important than Dolly – a blood test for neuro-biological ailments such as Alzheimer's disease. Roslin has 250 scientists and 32 principle investigators working traditionally on farm animal genetics, genomics and moving more towards biomedical and biotechnology research. Roslin recruits scientists globally and will seek the very best.

Science projects commence at the Roslin Institute by defining a new area of science first, then going out and recruiting a new principle investigator. Roslin will fund the principle investigator, the technicians and a 'wellfound laboratory'. It is the discretion of the principle investigator whether or not to expand his/her project by submitting various grant applications. John cites an example of projects where the core funds only support the principle investigator and one technician, while another 14-15 technicians are supported by outside grants. The evolution and growth of science projects often begin to generate results and intellectual property and deals starting to be discussed.

Roslin's structure for commercial exploitation of their science begins with the '*leaders of exploitation – the principle investigators*'. John states that their function is to identify any intellectual property that may have commercial value and can be

protected. To assist them, John provides training programs to increase their knowledge and understanding of processes of exploitation that include legal issues, patenting and licensing.

John states that one of the initial problems when Roslin began a more focused approach to exploitation was the cultural barrier among principal investigators regarding their perceptions of commercialisation, i.e. what they could say about the science, the time and effort needed for exploitation, etc.

Roslin has made great strides to facilitate a commercial awareness and involvement among their principal investigators through training, John states. He adds that these efforts have resulted in a greater acceptance of research commercialisation when scientists understand the benefits and opportunities, such as speeding up the patenting process, being able to discuss the science and publish once a patent is filed, etc, that can provide scientists with a greater level of academic freedom.

Scientists are thus a key factor in identifying the commercial potential of their science and John states that principal investigators are expected to know what the potential market is for the particular innovation and to make most of the contacts based on their networks. These networks could include biotechnology companies, the European Union, government organisations, etc. The principle investigator is always involved from the start in any negotiations with a potential commercial client.

Once a commercial opportunity is identified, John states that there is a split between his function and the function of the principle investigators. As the process gets underway, the principle investigator begins discussion with the other party's scientists to see whether some form of collaboration between the two organisations at the scientific level is feasible. Because as John states, "*the only work Roslin want to do is work that adds onto our scientific program, as we are not a contract research organisation*". If it is clear from the scientists discussions that collaborative work is possible and the personal interactions are positive, John then enters the process to provide all the '*backup mechanisms*' that include project costing and financial, legal

and contract negotiations. The role of the scientists is therefore focused only on developing the scientific program.

John states that approximately 95% of Roslin's science is exploited using the licensing process just described. What Roslin is looking for in a scientific collaboration is that the third party will fund normally a three-year research program at Roslin that will develop Roslin's intellectual property, with the average collaboration being £1 million.

In addition to the research funding, Roslin expects a royalty fee for any product that emerges. John concedes that this royalty fee may be small, particularly with 'stacking provisions' that will impact the return. Further, Roslin will attempt to secure some equity in the collaborating company, particularly if it is a small start-up biotechnology company, although John concedes this is not an option with the large biotechnology corporations such as "Big Pharma". In return for this deal structure, Roslin in return normally provides a license to Roslin's protected IP in a defined field plus any improvements that arise over the 3-year period. The licence, like any licence, is negotiable, states John, and the third party normally seeks to secure a worldwide license and Roslin will not be adverse to that request provided that the income generated is sufficient.

The second method of exploitation is the joint venture. This involves Roslin and another organisation setting up a joint company, with Roslin providing the intellectual property and the other organisation providing the funds. This is not a favoured option, John suggests, because it is usually complicated and will be undertaken only if there is no other way of exploiting the science.

The third and final method of exploitation for the Roslin Institute is the spin-out company. Two reasons are given by John to pursue the spin-out option. The first is where Roslin perceives a market failure – i.e. where there is intellectual property that has value but there is no one to license the IP. Roslin will then go to the market to

raise the money and set up the company themselves. One example of this route is PPL Therapeutics.

The second reason for the spin-out option is where Roslin has a technology that it believes is highly valuable and believes that a few more years of developing the technology will make it even more valuable. Therefore, rather than give it away to others to commercialise or licence it, Roslin will do a spin-out.

Roslin has set up five spin-outs to date of which four are still in existence. PPL Therapeutics is Roslin's first spin-out company that is now over 15 years old. Rosgen was a cattle geno-type company and John suggests it failed in its attempt to switch from an animal to a human market. Although the decision to pursue the human market was a good decision according to John, the company dumped the cattle market before they established the human market. The funders therefore walked away. Roslin Nutrition is a service company, and as services are no longer in Roslin's mandate, it spun the company out. John suggests that this company had good management, a strong drive to succeed and a niche market that they could develop.

Roslin Biomedical was Roslin's most recent spin-out, created in May 1997 to develop the technology that created the cloning technology and Dolly the sheep. Originally, Roslin had created two patents – Magic and Quiescence – that were filed in 1996, followed by the creation of Dolly, the world's first cloned mammal, in 1997. As John recalls, there was tremendous interest in the technology, from large corporations such as Big Pharma to "*some real charlatans*" on the other end. Roslin administration realised that whatever was being offered at the time, the technology was more valuable than those offers.

Roslin raised £6 million from venture capital group 3i. Both were equal shareholders, with Roslin providing the intellectual property and 3i providing the money. A high-profile CEO was recruited from the US, Simon Best, who was running Zeneca Plant Sciences. In November 1997 it became apparent to John and

others that the patents – that were only filed and not granted – were not going to be the vehicle to get products to market. There was no guarantee that the patents would be granted, as much controversy surrounded the cloning technology. Rather commercial success for the company was going to require “*an amalgam of quite a number of patents – technologies that were going to have to be put together*”. One of the groups that emerged was Genron Corporation from California who had complementary intellectual property related to tealameres.

Discussions began with Roslin and Genron purely on the scientific front. It became clear to Roslin that there was a deal to be done in putting the intellectual property together. At the time Genron was cash-rich and their view was to buy out Roslin Biomedical rather than pursue a joint venture or collaboration. The return included £12.5 million, a significant share holding in a quoted company and royalties. From Roslin’s point of view, John feels it was a very good deal. The programs to develop the cloning science were written by Roslin and agreed by Genron, with Genron receiving a licence – with an exception for PPL Therapeutic – to exploit the technology world-wide.

One of John’s business functions, as noted earlier, is taking equity in new biotechnology start-ups. Depending on the progress of these companies and should they go public, Roslin will tend to sell their equity and reinvest in something else, such as blue-chip companies and bonds. This provides an investment portfolio for reinvestment. At the same time, John points out that when Roslin wants to start something new and reinvest, it ‘pump-primes’ by using the normal institute reserves.

Money that is received by the Roslin Institute for its science goes to specific research projects. All projects are costed out, and the £12.5 million from Genron essentially reflects that amount in research over a 5-6 year period. Almost 50% of that amount is an overhead element – part of full economic costing of the projects – that goes to the operations of the Roslin Institute.

In pursuing any of these exploitation options, John states, Roslin focuses on selling its key asset – its science - rather than tangible products. As John states: *“If Roslin goes down that road of going beyond the basic strategic research attempting to produce products, we will not survive. There are too many people out there that have been at it for too long whom would be much better than us”*.

Roslin’s most recent commercial venture demonstrates this philosophy. Roslin Biocentre Ltd is a commercial site created in 1998 with the primary objective of gathering a critical mass of scientists and related organisations working in the life sciences sector. The focus is to generate interactions among companies and scientists that lead to informal and possibly formal collaborations.

10.5.1 Roslin’s View on Scotland’s Support Environment

John’s perspective on technology transfer in Scotland is one of uncertainty on what is attempting to be achieved. John suggests that many universities are too target-driven, e.g. number of spin-outs and amount of licensing income. John states that this sets an institutional logic for focusing on targets above all else since technology personnel are committed to delivering on what is agreed regarding pre-set objectives.

Regarding spin-out companies, John argues that the real question is not how many spin-outs are being set up but rather how they survive and prosper. The idea of the ‘scientist to CEO progression’ for a start-up is not going to work, John suggests, because of the lack of experience in business. The key factor for any spin-out to be successful, John asserts, is the management team. The quality of the intellectual property and the science is important, but John argues that a new company needs *“a damn good CEO and you need to pay the market rate”*. You also need to tie them in to incentivise them. He cites Roslin Biomedical as an example, claiming that strong leadership of the CEO leveraged the strong intellectual property that made the company attractive to Genron.

John poses a similar caution regarding use of licensing and income generation targets. It is the scientist that has to deliver, and if the scientist is not interested then output problems will occur. Roslin's approach to involving the principle investigator from the start reinforces its philosophy that the scientist always leads and agrees a scientific program. This is one reason why Roslin does not have a business manager. As John has seen in previous organisations, a business manager goes out and does a deal, secures a contract and investment and delivers the contract and deliverables to the scientist that may not want to be involved. The organisation is faced with a contract that they can't deliver.

A related problem around commercialising innovations and setting up companies, John argues, is that some Scottish universities demonstrate a lack of expertise in technology transfer – particularly in the ability to negotiate deals. One Scottish University has been difficult enough that John suggests Roslin is growing sceptical about future collaborations with them.

Besides institutional issues facing university commercialisation, John believes that Scotland must promote itself better within global markets, with the North American market being particularly attractive. Scotland has tremendous potential, according to John, because its science base is particularly strong. He suggests that in terms of the commercial-potential science regions in the UK, Edinburgh ranks third only behind Cambridge and London.

10.6 CONNECT'S DISTINCTIVENESS AMONG OTHER SUPPORT INITIATIVES

Connect distinguishes itself from other support initiatives “*by co-ordinating a broad mix of the right kinds of people sharing a common interest in supporting new Scottish-based technology companies*”, according to Connect Director Gillian Mayman. Provision of valuable information through a managed approach to event

topics delivered by dynamic speakers and relevance for multiple technology sectors also makes Connect distinct, she adds.

To avoid duplication of services with other initiatives, Gillian says that Connect works at establishing and maintaining a good working relationship with other agencies and gaining familiarity with their program, particularly those that fulfil different but complementary objectives. Connect's regional directors based in Edinburgh, Aberdeen and Glasgow regularly monitor these other support initiatives.

Connect from its early days has made a conscious effort to avoid political overtones, Andrew McNair suggests, and more recently Connect's sponsors and board have been explicit in advising that Connect should not be wasting time on public policy, public bureaucracy, or public politics. He suggests that this approach has contributed to Connect achieving a level of external credibility that separates it from private sector service providers.

Indeed, Connect's independence and neutrality is one factor distinguishing Connect from other support initiatives according to survey and case findings. This has allowed Connect to work with all the Scottish universities at the same commercial level, that includes linkages with the technology transfer offices and SIE students as much as it is consistent with Connect objectives. Connect's 'not-for-profit' mandate is also seen as facilitating an equal representation of stakeholder interests allowing Connect to focus on building a national network and creating its program.

There are limitations on what Connect can provide in its current role and CEO Ian MacDonald stresses that Connect will not become a consultancy because of the perception of conflict of interest. Ian adds that the general '*economic development role*' of Connect is to make the network function, and that role would be compromised if it became too service oriented and consultative. Taking a more consultative role would compromise public sponsors of Connect such as SE's LECs that are mandated to provide hands-on support services for new businesses in

Scotland as well as Connect's private sponsors, many of whom are professional service providers seeking technology company members as clients.

At the same time, Connect directors provide initial hands-on advice when plugging new technology company members into the network. As an example, Dr. Andrew McNair, in his role as Connect Director responsible for the west of Scotland and investment events, has commercial experience as well as technical expertise in life sciences and biotechnology. This advice, Gillian explains, is focused on assessing company needs and then directing them to the right people within the network or beyond.

Ian MacDonald suggests that Connect as a private company will take a more proactive role to help member companies specify their commercialisation issues for the future and what choices are available to them. He stresses that Connect will continue to take an active leadership role in preparing and linking new technology companies with investors, a function that Connect has championed through its high-profile Investment Conference.

ETF Director Keith Winton's suggests that the combination of multiple support initiatives with similar mandates and significant variability in quality of services will lead to Connect continuing to 'fill the gap'. He suggests that Connect is well placed to provide advice because other agencies often don't have technology-specific experience or access to Connect's extensive network of contacts.

10.6.1 Connect's Role with Universities and Research Centres

Critical to Connect's success is to be strongly linked to the university sector, states Connect CEO Ian MacDonald. All fourteen Scottish universities are public sponsors of Connect and use the network as an outreach mechanism to the technology and business communities. Ian asserts that this provides a strong motivation for private-

sector sponsors to join Connect as approximately 50% of new technology start-ups are university spin-outs.

Connect is a mechanism for breaking down some of these barriers between the university and commercial worlds identified earlier, according to Gordon McAndrew. When Connect began in 1996, Gordon explains that need was great to assist university-generated IP in becoming a commercial reality for the benefit of the wider economy as well as individuals. Gordon states that also needed at that time was an infusion of a variety of skills that were not normally within the skill-set of the entrepreneurial innovator technologist.

Since 1996, Gordon suggests that Connect has developed a 'risk free' environment to enhance the university potential for spin out. This is done by bringing together the university people with commercial people *'on the other side of the fence'* to demonstrate to those in universities that there is a difference and giving them an idea of how difficult it may be to commercialise their technology. He suggests that Connect is risk free because it is a friendly environment, people talk and come to talk.

One difficulty is trying to persuade academic institutions of the value of the technology-focused network of Connect. Connect Director Andrew McNair points out that some of the universities are very good at working with Connect but the larger universities are very poor because they've got a high degree of ownership. Glasgow and Edinburgh, for example, have a large staff in their technology transfer departments, as does Scottish Enterprise's LEC network. Andrew suggests that these departments and organisations have various company development teams, technology teams that *"are responsible for trying to justify their existence and complete performance project boxes"*.

Connect, on the other hand, is focused on trying to get academics in touch with independent expert advice and resources so that they may access a whole array of information that they can use and gain knowledge from.

Andrew suggests that Connect's "complement of events" have made new technology companies more aware that their founders don't have all the abilities needed for the full management team. As Andrew states, "*one issue is that it is very difficult to get technology companies to put their head above the parapet, as they are all very focussed in developing technology*". For example, Connect's 'technology briefing' event, focused on university projects, attempts to provide a spread of speakers and technologies and to discuss the various stages of commercial development.

10.7 DISCUSSION AND SUMMARY

Complementary initiatives operating alongside Connect are seen as operating at a number of levels. At one level are *commercialisation enablers* created to counter perceived gaps to forming technology companies. These include the SMART awards scheme and Proof-of-Concept fund from Scottish Enterprise, ETF seedcorn funds and the Royal Society of Edinburgh Fellowship Scheme. Case companies identify their usefulness for further developing their technologies and assisting company formation by providing market analysis and funds for salaries. Additional benefits include advice and guidance on company formation and directing companies to further support contacts.

Infrastructure enablers are identified to correct perceived regional socio-economic disadvantages. Connect and SIE have evolved a complementary relationship to educate students on entrepreneurship, stimulate entrepreneurial projects, and encourage students to start their own companies, leading to presentation at Connect's Investment Conference. At the business level, the Entrepreneurial Exchange also identifies a mission to make Scotland more entrepreneurial while providing a membership-based network for Scotland's successful entrepreneurs.

Intermediator initiatives that provide a business introduction service or "marriage bureau" for companies and investors is seen in the LINC program of Scottish

Enterprise with more general business information provided by the Scottish Enterprise LECs that operate more at the district level.

A number of issues are identified regarding the role of universities in supporting technology entrepreneurship. One is the potential conflict of interest of achieving university performance targets, e.g. income, patents, licensing deals, spin-outs etc. while ensuring the best interest of staff in their commercialisation decisions. One criticism of these targets is that how many spin-outs 'set up' is much less important than how many spin-outs 'survive and prosper'.

A counter-argument is whether scientists can be 'transformed' into entrepreneurs and CEOs and the assertion that entrepreneurial scientists will leave attempting to secure the best deal for their new company. The question arises whether universities should be maximising their returns or generating regional economic benefits by assisting spin-out companies with the assistance of external complementary initiatives. Connect suggests that universities utilise the Connect network as an *outreach mechanism* to the technology and business communities, but that its relationship with universities is not as active collaborators.

Multiple support initiatives and multiple points of entry to various support agencies are identified as a problem constraining support delivery in Scotland. Lack of co-ordination and failure to acknowledge features and benefits of existing programs contribute to the problem, according to some support initiative directors. Stakeholders identify various delivery problems that include lengthy application processes, lack of commercial experience and competence of advisors or advisors simply not understanding the technology and its implications in forming a company.

Connect identifies its active role in ensuring its uniqueness among complementary initiatives. Connect remains neutral and apolitical, monitors other initiatives and their services and provides technology-specific experience while providing its sponsors and members access to Connect's extensive network of contacts built up over 6 years.

CHAPTER ELEVEN

CONNECT'S EVOLUTION AS AN INDEPENDENT COMPANY AND REGIONAL FACTORS

11.1 INTRODUCTION

This chapter examines Connect's evolution from a public-private network-based program to an independent company. The objective is to identify changes to network events and activities, governance and communication mechanisms, value delivery to stakeholders and Connect's role among complementary support initiatives. This evaluation is based on interviews with Connect staff and stakeholders one-year after Connect's 'spin-out' (June 2002) and draws on insights from case and survey findings.

The chapter also examines changes to Scotland's business environment during the timeframe of the Connect evaluation (1997-2002) that are identified as relevant to understanding the evolution of the network, its effects on stakeholders and Connect's role within a regional system of support programs and initiatives.

11.2 CONNECT AS AN INDEPENDENT COMPANY

11.2.1 Self-sustaining Business Model

Financial self-sufficiency has been the first and most important operational milestone achieved one-year after spin-out. CEO Ian MacDonald states that the key question at the time of spin-out was simply "*can we sustain Connect without the public ERDF grant (approximately £300,000)?*" One year on, it is evident that the answer is affirmative. Connect has been successful in attracting revenues to hire new staff – web manager, database administrator, part-time accountant – and securing private

office space in central Edinburgh, thus growing the company during its transition year.

The primary source of this financial self-sufficiency is membership fees from sponsors and a membership renewal rate of almost 100%. This achievement is impressive given the volatile economic conditions for technology sectors in 2001 and 2002 and the operational challenges of disengaging from the university.

The self-sustaining model is based on a revised membership structure to the sponsor community. The previous flat rate sponsor fee of £3000, applying to all sponsors, has been replaced with a matrix cost structure that is banded according to the size of the sponsor organisation and sector. Table 11.1 below sets out the membership fees:

Table 11.1: Connect Membership Fees (since June 2001)

Membership Category	Employee numbers: 1-10	11-50	51 plus	Investment Conference
PRIVATE SPONSORS	£3000	£4000	£5000	
PUBLIC SPONSORS				
Universities/Research			£3000	
Not-for-profit	£1000	£4000	£5000	
COMPANY	£500 (annual fee)			£1000

More explicit benefit provision to sponsors are to: 1) gain potential business development opportunities; 2) promote their company and services on ConnectontheNet.com and highlight company developments through the site bulletin board; 3) receive discounted places at the Investment Conference; and 4) contribute their knowledge and experience to early stage technology companies.

The new self-sustaining model has also produced a revised company membership structure. Both Ian and Andrew note that Connect’s board voiced a collective concern that Connect was ‘giving away’ their services and Ian’s assertion was that ‘if a company wants to get involved in the Connect network, *“they will have to pay for it”*. Various revenue models were discussed, with the primary challenge one of

¹ European Regional Development Funds (ERDF) are investments for infrastructure and local development initiatives that should lead to the creation or maintenance of jobs. (http://europa.eu.int/comm/regional_policy/funds/prord/prord_en.htm).

attributing a financial figure to the value provided by Connect to new companies. A key consideration, identified by Andrew, was *'getting the Scottish mindset attuned to the value that the Americans already attribute to similar services'*.

Increasing company membership fees was based on the assertion that the original £100 fee for companies was heavily subsidised by public funds in the pre-spin-out model. Andrew states that initial discussion over a new membership fee to more accurately value the membership proposed a tiered membership package of £1500 for a new company that would provide up-front services for a new company entering the network, followed by an annual £500 renewal fee. This fee structure was based on estimation by Connect staff that the actual value based on the time and service provision for previous companies amounted to £10,000, based on consultant fees using a daily rate.

However, initial feedback from companies and Connect's board found that the majority of new companies could not afford £1500 and the model was rejected. An identified concern from most companies, Andrew found, was not the argument over the value attributed to the network but rather that companies simply did not have the funds available for the fees.

In its place, Connect identified a more realistic 'price-point' of £500 per year for membership, with investment events charged separately. Connect believes that in the first year, most companies will be eligible for the Springboard investment event, and an additional fee of £1000 is set for the investment events (Table 13). The choice of paying £1000 or deferring payment until the company attracts initial financing essentially creates a 'success-based' payment model².

The £500 fee covers access for all company employees to Connect core events, a listing on the website www.connectonthenet.com and discounts to Connect's investment events. In addition, members can promote their company and services on the website and access all areas of Connect's online network: post ads, question

² In 2002, actual Investment Conference fees were £500 for Connect members and £1000 for non-members.

Connect's online expert community, view archive presentations and post the latest company news and releases. Members continue to receive copies of Connect's newsletter, Jargon.

The most significant difference in value provision for technology companies with the new model is a more intense 'mentoring process for gaining access the know-how, resources and skills in the first 18-24 months of membership. This 'plugging into the network' process will be discussed in section 11.2.4.1.

Overall, Connect's mission has not changed since becoming a private company and remains: *"...to support the creation, development and growth of early stage technology-based ventures throughout Scotland"*. However, performance metrics for Connect are more membership-based in contrast to many of the original 4-year quantitative impact targets identified in Chapter Eight (section 8.3.1) that were focused on multi-stakeholder constituency-building at the regional level.

Connect's has created new quantitative targets explicitly aimed at 'membership' growth and retention that is directly related to revenue generation: 1) increase the number of member companies from 100 to 200 within two years (between 2001 and 2003); and 2) increase the number of private, corporate and public sector sponsors from 60 to 90 within two years (between 2001 and 2003). These performance targets are expected to establish a robust revenue stream to enable the effective and sustainable development of Connect as an independent, not-for-profit company.

Although these targets demonstrate Connect's ambition to 'grow' the network membership after a period of relative network membership stability since 1998, one observation is the absence of explicit targets for other stakeholder groups. Another noticeable omission is any economic impact targets similar to those originally established for Connect's first four years (1997-2000). However, this research has identified key limitations in attributing economic output targets to Connect that

include the indirect role of Connect³ and regional factors challenging achievement of targets such as number of spin-outs and university-industry collaboration.

11.2.2 Network Events

Connect's current mix of recurrent events – '*meet the entrepreneur*', '*enterprise workshops*' and '*technology briefings*' remain the cornerstone of network activities. Connect continues to provide formal knowledge-based topics that encourage stakeholder attendance and stimulate interaction, collaborations and value flows described in Chapter Eight. Investment events continue to operate as before.

However, one identified weakness in facilitation of recurrent events previously was their abstraction in terms of outputs, explained by Ian MacDonald as '*the problem of planning these events to be of interest to all the communities in the network*'. A revised 'lifecycle of events' strategy has emerged with the new model that reflects a more integrated structure and flow of topics.

The three recurrent events are now integrated within a two-year 'lifecycle' that attempts to run in parallel with a new company's business lifecycle. This recurring program mix will start every 9 months to allow recent company members to enter into the program and realise a complete lifecycle of event topics that cover key company formation issues. Ian suggests that this event cycle is driven by stages of funding that many technology companies in the network will have in common despite their technology peculiarities and differences.

A further justification for this lifecycle-based provision of events is to benefit private sponsors who are able to determine where companies are located according to their needs and level of development by the events they are attending. However, one concern with this approach is the potential loss of sponsor attendance at early events, when companies would benefit most from sponsor's social capital, experience-based

³ In May 2001, CEO MacDonald identified the need to create more 'realistic and relevant' targets for the future.

advice and knowledge but are too early to be perceived by sponsors as going concerns.

11.2.3 Network Management Mechanisms: Governance and Communications

The governance of Connect has changed with the appointment of a professional Board of Directors that have legal obligations as of September 2001 to, among other things, “*ensure that Connect is doing ‘appropriate things’*”. Prior to this time, Connect’s board was an advisory board, as Edinburgh University performed all of the administrative, line management and financial decisions for Connect. This trade-off with the university, Ian concedes, provided Connect with a number of benefits. Overheads were waived by the university on the condition that Connect would not receive or expect subsidisation from the university. Premises at the Management School and administrative support were provided to Connect. An interesting comment by Ian in hindsight suggests that Connect was able to perform relatively autonomously from the university in terms of its mandate.

Connect’s new board structure is perceived to be more inclusive of stakeholder needs and expectations. Andrew McNair points out that the new Connect’s board is nominated from sponsors and member companies, allowing sponsorship representation, company representation and entrepreneurial representation. He asserts that the long term capability and vision of Connect, to grow the technology company community and make it prosperous, also provides a level of stakeholder integration that will ensure that the network of sponsors will continue to maintain its involvement and interest socially, knowledge-wise and financially.

Connect staff are more focused on higher standards of service provision to ensure that sponsor membership retention remains high, not unlike other service-based companies. A more resource-based operational philosophy has emerged with specific performance-based job descriptions outlining where and how Connect staff

will add value to the company. For Connect's directors, this includes the number of 'man-hours' employed to attract new company members into Connect.

The importance of this service orientation to sponsors has resulted in Connect Director Gillian Mayman, previously Program Director, taking on a new role as Sponsorship Director. Andrew estimates that since the revised model was introduced, an additional 20 percent of 'new effort' from Connect's directors has been dedicated to talking with new companies and sponsors. A continuing challenge for Connect staff, identified in Chapter Eight, is to market and promote Connect to a broad cross-section of technology sectors and to know what events and issues are applicable to what sectors. This requires maintaining an 'ear to the ground' to keep abreast of ongoing issues and how these are relevant to Scottish companies as well.

Managing and directing Connect as a spin-out company has provided CEO MacDonald with numerous challenges. Ian concedes that he had to '*learn how to set up a new company*', a somewhat ironic confession given that Ian has been involved since 1996 in providing start-up and commercialisation advice to numerous technology companies. In hindsight, Ian provides some lessons:

- ❑ Set up the board early.
- ❑ Organise and confirm legal issues of company set-up early, contracts for employment, intellectual property (IP) and trademark issues.
- ❑ Cash-flow forecasts and projections take a considerable amount of time, particularly when the economy is in a down-turn. Accounts receivable has become a particular issue for Connect in this economy. Although Connect's payment period is net 30 days, average accounts are taking over 90 days, creating significant cash flow issues. Ian concedes that cash flow is the most serious challenge to Connect's solvency as a company.

Network communication continues to rely primarily on referral and recommendations between Connect staff and the wider community and among network stakeholders. However, communication mechanisms since June 2001 have

become more dependent on networking technology in the form of www.connectonthenet.com.

The web presence is expected to counter an identified weakness of regional inclusion particularly in the north (Aberdeen, Dundee and the north west) by directing knowledge flow to stakeholders and providing an open two-way communication channel. The site can also provide up-to-date information on Connect's events and activities and act as a medium for customised information and advice flow among companies, Connect, sponsors and others using confidential password access.

Findings suggest that networking technology will not supplement face-to-face interactions facilitated through Connect's various events. Findings in Chapter Eight suggest that the diverse, unpredictable, informal and unmanaged flow of information and knowledge generated at recurrent events cannot be duplicated using technology mediums nor can the building of social capital, reputation, trust or credibility be developed through them. Both 'what you know' and 'who you know' have been identified as particularly critical in a Scottish context.

11.2.4 Value Delivery to Stakeholders

Strengthening the ties between sponsors and members within the network lies at the heart of enhancing value provision in the revised model. Connect stakeholders are becoming '*more aware of why they are doing what they are doing*', according to Ian MacDonald. More and more, stakeholders are looking to spend their time as efficiently and productively as possible. Utilising contacts that are developed within the network becomes increasingly important for new companies, and selectivity of discussions arise as entrepreneurs become more confident regarding their business proposition.

A '*sales pipeline*' can be used to conceptualise how Connect is more actively engaging potential sponsors and members. At one end of the pipeline, Connect

directors are focused on pitching to potential members and sponsors and 'closing deals' for a commitment (subscription) to the network. At the other end, Connect's efforts are expected to provide benefits – particularly investment – for member companies and also provide sponsors with benefits, among them access to new technology companies joining the network.

The effectiveness of this pipeline will be affected by a lack of investment in technology companies at one end that constrains the ability and willingness of companies to commit to joining the network because of the membership fee. As sponsors rely on the influx of these new companies within the network to establish relationships and assess their client potential, any impediment of new companies flowing into the network will affect sponsor benefits. Thus, pipeline inflow and outflow are influenced by sectoral conditions.

The greatest impact on new technology companies since 2001 is the increased time required to secure an investment deal, from 3-6 months to 9-12 months, according to Ian MacDonald. Although Ian suggests the supply of money has remained relatively stable, he cautions that the longer time period for raising capital has increased the risk of exposure to Connect's member companies as competitive new opportunities develop and arise during this longer period of time. Thus the window of opportunity for companies has shortened.

Chapter Eight identifies the effect of varying technology market conditions on company membership retention since 1997, suggesting a paradox in that benefits of a supportive network may be most appropriate for new companies when market conditions are challenging, but they may not be able to afford Connect's higher membership fees.

Connect CEO Ian MacDonald was asked to respond to this suggestion of a paradox. He notes that serious new ventures will commit while the less serious may turn away and states: *'if a new company cannot afford to spend £500 on Connect, they may not be worth the time...in other words, we want to attract the more serious companies'*.

In reiterating Connect's new 'membership-based' model, Ian's asserts that 'if a company wants to get involved in the Connect network, they will have to pay for it'.

Underlining Ian's assertion is Connect's more explicit objective of ensuring business opportunities to sponsors, suggesting a level of company member selectivity on the part of Connect. This rationale can be summed up by Ian's statement, "*if we drive companies into Connect, what sponsors will follow?*" Findings from Chapter Eight identified the growing expectations of sponsor returns on their membership – i.e. 'deal-flow' while also identifying high value associated with network knowledge.

Creating sponsor expectations of deal flow is dependent to a large degree on investment opportunities available for high potential companies to become sponsor clients. Already identified in Chapter Eight is the correlation between social and financial value and the fact that emerging investor groups in the network are individual members and other technology companies. This suggests that too selective an approach to matchmaking and focused value provision only to companies and sponsors runs the risk of losing key value-adding elements of the network.

Case study findings suggest that Connect needs to maintain interest in the network by experienced entrepreneurs and managers. Management and investment go hand-in-hand with almost all case companies identifying the need for experienced commercial managing directors across all technology sectors. One problem for a biotechnology company, identified in the case studies, is finding not only experienced investors but also experienced managers in a sector where time-to-market is so long. Lowering search costs for companies as they develop highlights the importance of a broad multi-stakeholder network constituency that continues to be attracted to the network.

11.2.4.1 'Plugging' New Companies into the Network

Connect's mandate to increase value provision to member companies begins with an initial meeting with one of Connect's directors. Most prospective company members arrive at Connect with a technology in need of protection, a need to know about competition for their innovation and weaknesses in their business 'offering'.

Upon a registration of interest by a prospective company member, Connect first establishes its criteria for a new company - that they conform to the definition of a technology company (companies competing on the basis of proprietary technology or know how). An initial meeting is then set up with one of Connect's regional Directors to discuss the company's business model, i.e. where they are, where they want to go and who they needed to talk to – legal, financial, marketing, etc. Andrew McNair concedes that Connect is quite straightforward with prospective companies regarding their innovation potential and assessment of how Connect can assist them. Connect also attempts to make it clear that although the initial meeting (or follow-up meeting) is complementary, any initiation of assistance will require the company to join Connect.

Once a company joins, it is then 'plugged into the network' by introductions to recurrent events, being set-up on the Connect website and being given preferential access to investment events 'springboard' and 'bootcamp'. These two investment events are aimed at solidifying the market opportunity and business proposition in preparing the company to present to serious investors at the annual Investment Conference.

Making introductions on behalf of the company is one of the services provided by Connect. However Andrew cautions that this role could easily evolve into a non-executive director role for Connect Directors, so care is taken in ensuring that guidance and direction does not become ongoing support and advice that the company becomes reliant on for their business decisions.

The initial one-on-one time spent with a new company member by Connect varies, according to Andrew. Although he does not closely monitor the hours spent with each company, Andrew takes the example of an Edinburgh University spin-out company who had received a SMART Award in 2002. Andrew brought in an active Connect company as a syndicate partner to assist the new company in proving their scientific principles and made contacts with potential investors on behalf of the company. Andrew estimates that he spent 3 days with the company during their first week as a Connect member.

11.2.4.2 Universities

Connect's transition to private company has not changed the benefit provision to universities; providing them with a private-public network of commercialisation support, access to technology ideas and more direct support for investment. The benefit of the network for university spin-outs, Ian adds, is to provide a proactive community of support that the universities can use for their spin-out companies to 'plug into'. This saves the universities time and resources by providing a ready-made route to market for scientists and researchers attempting to exploit their innovations. At the same time, Connect allows university technology transfer offices to develop and utilise links to investors.

However, the attitude taken by Connect in dealing with universities has changed since June 2001 according to Ian MacDonald. Previously, Connect went to universities in an attempt to persuade them to be 'more entrepreneurial' but Ian concedes that Connect can't change that, so Connect is now more focused on informing the universities of its events and activities.

Ian MacDonald describes technology transfer offices as essentially '*IPR incubators*' with the role of providing support for companies or potential ventures (clients) in which they have (or will have) an equity stake. He suggests that involvement with Connect is often motivated to gain access to people and resources they need in order

to realise value from these innovations. Essentially, this role is quite business-like and formal.

Connect directors concede that some universities are much more receptive to Connect than others. Andrew McNair argues that some Scottish universities remain ‘owner-oriented’ and the result is that negotiations over intellectual property (IP) take far too long. He cites two recent examples of spin-out companies that have experienced commercialisation constraints because their critical time-to-market technologies have been held up by IP negotiations. External negotiations with investors will not normally proceed unless there is a letter from the university outlining the position of the technology – i.e. the ownership, based on Andrew’s experience working with university spin-outs.

The Springboard event in fact was originally designed for university spin-outs and over 50% of presenting Springboard companies are universities spin-outs. Technology Briefing events are also designed to allow academics to present their work on innovations and to facilitate potential collaboration among academics active in the network. Findings from Chapter Eight, however, identify the low participation level of universities at these events that suggests the event objective of facilitating university-industry collaboration is not being realised.

Andrew argues that another issue for some university technology transfer offices is their perception of ownership loss if academics attribute more value to Connect than to their own university commercialisation staff. This is misguided, Andrew asserts, because it is clear in Scotland that the IP always initially resides with the universities, providing universities with a natural link with academics.

An ongoing challenge in commercialising spin-outs remains the ownership role of universities and the commercial needs of an emerging spin-out. A common expectation of all technology investors is to identify ‘*disruptive technologies*’ - those innovations that clearly will change the way things are done in a particular sector, according to Andrew McNair. Although investors may concede that the technology

is promising, they want to see market diligence, contact with customers and a sustainable business model with a product pipeline as prerequisites. Universities cannot provide all these requirements.

11.2.4.3 Innovation Creators: Scientists and Researchers

The role of Connect with academics and spin-out companies is significantly different than its role with university administrators and technology transfer personnel. Connect directors often advice academics on issues related to ownership of technologies, usually suggesting to academics to avoid lengthy, drawn-out arguments with their universities over equity position and ownership. As Andrew states, “*give the university their 20% equity...the most important thing is to get the technology signed over to the academic if a new company is the goal*”.

Connect also identifies a ‘*confused academic syndrome*’ whereby academics are naive on commercialisation processes and confronted with an overwhelming amount of advice and information. One problem suggested by Andrew is that advice from technology transfer personnel may lack ‘real-world reality’, particularly when it comes to advising academics on private-sector investment processes.

Since 2001, Connect directors identify a growing level of knowledge and assertion on the part of academics in commercialising their innovations in Scotland. One reason is the hands-on processes by which academics apply for funding – the Proof-of-Concept Fund, Royal Society of Edinburgh Fellowships, etc – that encourages critical thinking about the technology and its relation to the market. This trend has also placed the technology transfer offices under more pressure to respond to more knowledge-based queries from their academics, Andrew argues.

There is also a growing trend, Andrew sees, for younger academics – non-tenured academics, post-doctoral fellows, etc – to see a commercial career and leave the

university to start a company. This trend was identified in case studies in Chapter Nine.

11.2.4.4 Complementary Initiatives

Connect has made more explicit its positioning as a regional support program: 1) to develop connectonthenet.com as a knowledge portal for the Scottish technology-business community; 2) to strengthen existing collaborative activity with initiatives such as Proof of Concept Fund and the Scottish Institute for Enterprise to maximise membership opportunities; and 3) to partner with related organisations and initiatives within the UK and Europe to stimulate additional opportunities for members and sponsors.

Since 2001, Connect directors suggest that collaboration with other bodies supporting technology entrepreneurship has increased and improved. One explanation is that Connect, in providing a more focused business model, has identified boundaries and thus its limitations on where it provides value. Another explanation is the increasing accountability of Connect to its professional Board of Directors. As a public program, Connect was able to develop various programs without rigid monetary and performance guidelines, as Program Director Gillian Mayman states, Connect had “*latitude without preconceived expectations*”.

Connect’s relationship with its larger public sponsors had previously placed Connect in the role as recipient to the mandates and expectations of these larger players, since they represented Connect’s primary funding source. As a private company, Connect can operate autonomously and on a subcontract basis with these agencies, whereas previously, Connect provided information, advice and services on an ‘as asked for basis’.

Connect has changed somewhat as a private company, according to Dr. Keith Winton, ETF Director, who viewed Connect when it was based at Edinburgh

University primarily as a program to link universities with the commercial world in Scotland. Keith now suggests – with Connect a private company external to the university – that Connect is *now on the commercial side of the wall looking back at the universities rather than on the university side of the wall facing the commercial people.*

Although Keith suggests it is too early to tell, he sees Connect's new role as an 'industry body' - with good contacts within the universities. Any improvements in linking these two sides will provide a much-needed service in Scotland, he adds. He also suggests that Connect 'in its old guise' may have been looked upon by some of the university technology transfer offices as direct competition.

11.3 REGIONAL CHALLENGES TO TECHNOLOGY ENTREPRENEURSHIP

The evolution of Connect in its first 6 years – 1997 to 2002 - has coincided with unpredictable global markets for technology as well as regional challenges peculiar to the UK and Scottish context. For example, Scottish policy makers view the biotechnology sector as a key to technology growth since the demise of the electronics industry in 2001 and 2002⁴. Findings in Chapter Eight identify that technology market volatility is reflected in the varying levels of investment and types of sectors gaining investment as well as the level of Connect companies retaining memberships and no longer trading.

The cyclical nature of the technology sector has not diminished sponsorship support for Connect as identified by high renewal rates discussed earlier. Connect Sponsorship Director Gillian Mayman gives one explanation of high sponsor retention. She suggests that Connect's founding sponsors provided optimistic visions of the future of the technology sector back in 1996/97 that justified their decisions to

⁴ Biotechnology employs more than 24,000 people in Scotland in 430 organisations. Since 1999, the level of growth in the industry in Scotland has been 30 per cent a year, almost double the European average (Scottish Enterprise, 2002).

become involved in Connect. At the same time, she suggests that many people did not understand the technology marketplace and it was this concern with not having a grasp of the industry that drew people to the Connect network.

CEO Ian MacDonald suggests that another reason for sponsor vigilance in supporting technology is its importance to the Scottish economy that recognises, first of all, Scotland's over-dependency on foreign corporations and second, the high potential of economic benefits to be derived from Scotland's strong science and technology base. Ian suggests that under strong market conditions, sponsorship is distributed to a number of various support programs, but during a down-turn, the level of sponsorship will become highly selective. High retention confirms a longer-term focus and an indication of the growing maturity of the technology sector and its supporters in Scotland.

Connect Director Andrew McNair argues that the technology community in Scotland has become more sophisticated since 1998 due to tangible, incremental improvements that include growing competition for young technology companies, as more investment has become available. Andrew identifies a noticeable shift in attitudes from those involved with the Investment Conference between 1998 and 1999, and suggests that presenting companies were suddenly a lot more bullish about their options and opportunities. He also suggests that the power base has shifted somewhat from advisors and funders to these new companies and credits the quality of proposals and increased awareness by technology entrepreneurs regarding investor expectations.

The entrepreneurial culture has changed particularly at the source of technology innovations, the Scottish academics, according to Gillian Mayman. She suggests that the traditional academic focus on the technologies themselves has evolved to the commercial applications of these technologies. A number of reasons may explain this change. Successful companies and wealth accumulation have provided role models for other academics and researchers. Academics have a greater awareness of what is required to commercialise their innovations. The role of technology transfer

departments has also given a greater awareness to the push toward applying university research.

Professor John Wilson of DILAB suggests that with changes to academic life, such as less freedom to pursue research interests for example, more academics are pursuing commercial opportunities in the UK. At the same time, John remains in academia only because DILAB has yet to realise a viable market position, and he continues to balance his commercial and academic roles. Indeed, case studies identify a combination of ‘push’ and ‘pull’ factors influencing decisions to leave academia to start a new company.

With success has come a greater cultural acceptance of the entrepreneur as a legitimate occupation in Scotland, according to Gillian Mayman. Successful entrepreneurs, with their experiences and lessons, now provide knowledge, social contacts and investment to new entrepreneurs and companies. However, evidence by the Global Entrepreneurship Monitor (GEM) suggests that entrepreneurship levels in the population of Scotland remain among the lowest in Europe⁵.

Connect Director Dr. Andrew McNair describes cultural and social change in Scotland as “*a slow process or a ‘drip effect’ when attempting to change the status quo*”. GEM Scotland provides evidence to suggest improvements are being made through educational tools to encourage younger people to become entrepreneurs (GEM Scotland 2002), while the Scottish Institute for Enterprise continues efforts to stimulate new venture creation by university science students.

Not everyone agrees that change in Scotland is occurring fast enough. Sales Director Euan Robertson of case company ‘*Spektra*’ argues Scotland is ‘abysmal’ in knowing what other businesses are doing and suggests that many companies know more about what is going on in the US than in Scotland. He views the Scottish culture as a barrier, suggesting that “*it is very un-Scottish; getting up there and telling others what your business idea is*”. He adds that people with money that have been

successful are looked upon with scepticism; as if to say “*what did you have to do to earn that money*”. Being demure and keeping information to oneself, he adds, is hurting the development of a creative, innovative and adventurous economical climate in Scotland.

Gareth and Scott of case company ‘Yaba’ describe the effects of Scottish investors being non-adventurous with their money. Scott concedes that since Yaba joined Connect, he has seen more venture capital available in Scotland. However, he suggests it is the same investors and they remain risk adverse, stating: “*it is often the same venture capitalists... companies are still not surviving because, even when they achieve milestones the investors often decide to pull the plug too early*”.

Gareth and Scott add that investors should be realistic regarding outcomes from an initial round of funding- in other words, these funds should provide a few milestones, but should enable the company to “go and see what they can do with it”. But they argue that investors cannot expect everything, and they suggest that initial financing is short-sighted in Scotland. Indeed, both Yaba and ExpressOn identified investor expectations as a significant limitation to their commercialisation efforts.

Gareth suggests that many investors want to see a level of stubbornness and conviction from founders but argues that this can waste time and resources. He describes his experience in commercialising a new technology “*like an assault course for the Royal Marines...you have to demonstrate that you have the will to carry on*”. That is not necessarily the problem in Scotland, he adds, rather it is a clear identification of those actions that are wasteful and unnecessary and not helping the Scottish economy. During the commercialisation process, Gareth states what is really important is getting the right people to act on your behalf. He states “*no matter how many support mechanisms there are, at the end of the day market forces and investors’ feelings are what dominate*”.

⁵ The Total Entrepreneurial Activity (TEA) rate for Scotland in 2001 was similar to that for 2000 - placing Scotland in the lowest of the three level of the 31 nations taking part in the Global Entrepreneurship Monitor (GEM Scotland 2001).

Despite evidence of improvements in regional technology entrepreneurship, findings identify that there is still much more effort needed to link the university environment with the commercial one. Although an explicit objective of Connect is to involve research-intensive SMEs and larger Scottish-based corporations, economic data shows that Scotland's uptake of university innovations by SMEs and corporations remain among the lowest of UK regions⁶, identifying key problems in the industrial structure and its ability to leverage regionally emerging technology opportunities.

11.3.1 Regional Opportunities

A small population base in Scotland of 5 million people has been suggested as a major challenge for competing in a world market and commercialising high technology innovations and inventions from its home base. Former Connect Board Member Gordon McAndrew suggests that Scotland needs to recognise the limitations by being selective about the technologies that are commercialised. He suggests that it would be very difficult for Scotland to enter major aerospace industries, major chemical processing type industries, which have a lot of technology, simply because of the scale of them.

Scotland's real niche can be in having centres of excellence⁷ that act as centres of innovation provision to third parties, according to Gordon. This could include a variety of commercialisation options such as inventing the products and selling them on to a distributor or licensing and manufacturing the product. Gordon sees the future opportunities lie in being able to be innovators through centres of excellence that can be very small or very large and potentially owned by multiple owners to achieve maximum impact on the Scottish economy.

⁶ As a percentage of GDP, Scotland's business research and development expenditure is 0.53%, compared to 1.27% for the UK and an OECD average of 1.54%. Scotland is third-bottom in the list of UK regions in terms of new business start-ups, as measured by VAT registrations per head, and has been so, on average, for more than 10 years. Scotland's start-up rate per head is around 85% of the UK average (Scottish Executive, 2001).

⁷ Scottish Executive announced the creation of three Intermediate Technology Centres (ITCs) in December 2002 that have an operational philosophy and mandate similar to those suggested by Gordon in June 2001.

One practical restriction in commercialising technologies is the area of management skills and human resources. Scotland traditionally has found a lot of its people wanted to work out of the country and therefore has been a feeder of skills. Gordon McAndrew suggests that Scotland has always had an outward-looking perspective because of limitations in prospects and salaries and the size of companies.

Findings suggest that the pool of potential non-executive directors is small in Scotland with the same people seen to be involved in many companies. Gordon suggests the need for a larger ‘gene pool’ of experienced commercial managers as one of the greatest challenges for technology sectors in Scotland. Although organic growth may eventually accomplish this need, Gordon argues that the challenge is that existing technology companies must grow – i.e. Scotland must have some high-growth technology successes – that allows for successful staff to ‘spin-out’ of these companies and be recycled among new companies.

Even today, Gordon asserts that there are not many large companies in Scotland and thus not a need for many management skills at a top level. The acquisition of Scottish companies is a general trend and new companies often do not replace acquired companies. Gordon feels that Connect can play an important role in maintaining a register of people who might be appropriate as part of a management team but that Connect shouldn’t be the provider of non-executive directors to new companies as a potential conflict of interest with its service provider sponsors.

11.4 DISCUSSION AND SUMMARY

Connect has evolved into a private company necessitating a self-sustaining revenue model in managing its network. Higher membership fees, growing expectations of deal flow by sponsors and the need to facilitate the entry of high potential member companies are drivers of this new management approach. The expectation is that tangible benefit delivery to sponsors and companies are more likely to be realised through a more mediated approach to reciprocal value exchange.

Greater value for money provision with the new model has seen Connect evolve into more of a mentor for new company members, a change to its original mandate to facilitate network interactions. The objective of this mentoring role is two-fold: 1) to identify relevant technology companies that have high potential and are relevant as potential clients for Connect's array of public and private sector sponsors, and; 2) to introduce and assist new company members, based on their requirements, in finding appropriate supportive agents, resources, information and knowledge with a customised approach to 'plugging them into the network'.

The evolving network management role of Connect can be identified with growth phases in evolution models of the firm; more formal operational structures, a professional board of directors and increasing company performance targets related to revenues. Job descriptions and responsibilities have become more focused on service provision to attract and retain memberships.

Overall, quantitative performance targets have emerged that are directly tied to the self-sustainability of Connect and its revenue generation. Qualitative targets identify the greater role for the Connect website in supporting sponsors and members and more active collaboration with regional complementary initiatives and other regional support networks.

Since 2001, Connect's role with universities has become less active in promoting entrepreneurship and more focused on simply informing the universities of events and activities. Connect is rather more focused on the academics themselves, attempting to provide an 'honest broker' role in dealing with their respective universities and exposing them to external sources of support available in the network.

Connect's evolution has coincided with a cyclical technology marketplace that has affected company membership retention. However, sponsorship retention has remained high, suggested by the importance given to technology entrepreneurship for Scotland's economic future by public and private institutions and their members.

Changes in the regional entrepreneurial culture are most identified with changes to academic entrepreneurship at the source of the technologies rather than the universities themselves. Successful companies and wealth accumulation have provided role models for other academics and researchers that provide a pull factor to leave the university and enter the commercial arena. Case study findings suggest that academics have a greater awareness of what is required to commercialise their innovations and changes to academic life, such as less freedom to pursue research interests, are providing a push factor.

Technology companies from the Connect network identify ongoing commercialisation challenges that include a low-risk investment community and longer-view of investment, lack of available experienced commercial expertise, lack of local market demand factors, constraints from technology transfer offices and the lack of a vigorous entrepreneurial culture and churning of successful entrepreneurs and companies within Scotland.

CHAPTER TWELVE

DISCUSSION OF RESULTS

12.1 INTRODUCTION

This chapter synthesises results from Chapters Eight through Eleven and applies them to the three sets of questions that has guided the research.

12.2 RESEARCH QUESTIONS ON REGIONAL SUPPORT NETWORKS

The first set of questions was related to network theory and practice and its relevance to a regional enterprise network as an intervention program. How is the network created; why and how does this network matter and more specifically - does a regional enterprise support network make a difference and to what extent? Further, how does this network change over time as suggested by evolutionary network theories?

12.2.1 Network Creation and Formation

Findings show that the creation of a regional network - Connect Scotland - cannot be traced to one single factor, such as a policy decision, common in public programs, to 'correct' a perceived market problem or market failure but rather is traced to a combination of factors.

Connect Scotland originated as an *entrepreneurial event*, based on an academic entrepreneur's vision and identification of a market opportunity. The market opportunity – to transfer a successful US model, Connect San Diego, to Scotland was

based on Ian MacDonald's view that similar circumstance were evident in Scotland in 1995 that existed a decade earlier in San Diego: the need to diversify a regional economy and stimulate high technology entrepreneurship.

Following a common approach of an 'opportunistic entrepreneur', Ian immediately sought support from high-profile public and private supporters to lend credibility to the idea. Ian began his search using his most immediate circle of influence, Edinburgh University. Bypassing departmental hierarchies, he went to the university's principal, Sir Stewart Sutherland, and secured support and a home for the program.

The Principal of Edinburgh University was instrumental in facilitating Connect's base in the Management School, partly because Connect San Diego was also based at a leading research university, the University of California, San Diego. A more important factor was realisation by the Principal of the potential role of Connect in championing a science and technology linkage between Scottish universities and the high technology sector in Scotland. As will be discussed later in the chapter, this championing role and effect has not been fully realised for a number of reasons.

The spill-over effect of support from Scotland's leading research university lent credibility to the Connect concept and was a key factor in drawing in support from the other thirteen Scotland's universities within two years. Private sector support using one of Scotland's most visible and successful entrepreneurs also secured a critical mass of 20 private sponsors, although this was the result of leveraging the extensive business network of Martin Ritchie. High-profile public and private 'legitimisation' of the concept created the momentum to build a Connect program in Scotland.

Despite the entrepreneurial 'push' from Ian MacDonald and a successful model to emulate, creating another intervention program in Scotland could not have been realised without the market need or 'pull' evident in Scotland in 1995. Indeed, Martin Ritchie shifted from his initial negative impression of Connect; 'the last thing

Scotland needs is another support program'; to a realisation that no other agency in Scotland was 'pulling it all together'. Other agencies, such as Chambers of Commerce and business forums, were creating networks of professional communities. But Martin sensed the value of putting in a link between these professional communities, the link being the focus on high technology.

A market need was supported by comparative research from Scottish Enterprise (1995) and other sources that identified poor networking between industry and academia and the absence of informal networks, mutual support and encouragement for entrepreneurship. Indeed, government documents from this period argue for the need to address inadequate regional support conditions in Scotland.

Using Burt's theory of *structural holes* (1992), Scotland's technology community in the mid-1990s can be conceived as a network where people and institutions were unconnected. These 'holes' provided the opportunity for an investment in social capital and the Connect San Diego model was identified as an appropriate model to link together people and institutions and thus fill some of these structural holes. The Connect model would bring together regional supportive agents and technology opportunities, unlike more traditional forms of hands-on mentoring support and advice focused on individual companies.

Ian MacDonald had aligned his idea of a *Connect Scotland* with a policy maker audience that was already aware of the relevance of the San Diego model to the Scottish context. Strong evidence of need is identified in evaluation literature as a common pre-condition of successful intervention programs (Patton 1990) and the original Connect San Diego model, with its emphasis on creating infrastructure conditions and networking, was particularly compelling for Scottish policy-makers and had in fact been identified as an appropriate model in public documents.

A key formation factor and advantage over newly created support programs was the adoption of a network management model from Connect San Diego, many features of which Connect retains seven years on. This model was then piloted in the

Edinburgh region to ‘prove the concept’, and a successful pilot generated further support to duplicate program delivery across Scotland.

A summary of key creation and formation factors of the regional network are shown below:

- Network champion; providing the idea, entrepreneurial vision and drive;
- Compelling regional need for intervention; consensus that there is a ‘problem’ and actual absence of social capital and networking;
- Relevant network management model; transferability of Connect San Diego model and operational structure;
- Activating high profile public and private sector ‘legitimisers’;
- Targets for stakeholder critical mass, mix and quality of events;
- Explicit identification of network stakeholders and benefits;
- Dedicated and competent management team; consistent personalities and interface for network participants and ability to promote concept regionally; and
- Regional representation and inclusion of stakeholders; people and institutions.

12.2.2 Connect Constituency-building

To attract and retain the regional communities supporting technology entrepreneurship and to stimulate their interactions, Connect explicitly states benefits to all these communities that establish preliminary expectations. Although categorised according to common characteristics, e.g. universities, private sponsors, member companies, each ‘stakeholder’ represents a set of expectations and motivations that first draw them to the network.

Payment of annual membership to join the network implies that a decision to become a sponsor or member involves a cost-benefit analysis at some level. Theories of social capital (Granovetter 1982; Burt 1992) argue that people invest in social

opportunities from which they expect to gain or profit. Williamson (1985) suggests that transaction cost economics motivate entrepreneurs and enterprises to minimise communication, information search and other costs associated with seeking resources, capabilities and customers. On the other hand, Zajac and Olsen (1993: 137) argue that transactions involve a 'joint value maximisation principle' whereby the focus is on exchange partners and the emphasis on collective value.

Stakeholders also consider reciprocal value possibilities in meeting with Connect directors and attending their first events. Stakeholders bring to the network a history of business transaction relationships and associated expectations with regard to future business transactions, referred to by Berger *et al* (1995: 1999) as '*temporal embeddedness*'. As individual or institutional interests are presented and the potential for mutual exchange explored, stakeholders cannot help but consider the costs and benefits of exchange.

Of course, the logic of collective benefits does not preclude those motivated by self-interest who do not invest resources in mutual gain. The *free rider* phenomenon may occur from a conscious decision not to contribute or the lack of resources to exchange (Olson 1965). Indeed, Connect directors identified their concern with some participants attending numerous events without committing to a membership. Although there is not direct evidence of the free rider phenomenon between stakeholder groups, survey feedback identified a low level of social interaction from some university commercialisation participants.

Findings support Williamson's transaction cost argument that Scottish technology companies are attempting to minimise search costs when considering the high level of network flow-through of company members after one year, taking into account start-up failure rates described in Chapter Eight. Heightened market uncertainty for new technology-based companies places a premium on the ability of entrepreneurs to integrate specialist knowledge and access expertise from a variety of local sources. Yet, entrepreneurs and new companies 'searching around' invest little social capital

and weak intermediary ties between Connect and these new companies allow them to easily disengage from the network when opportunities are realised or are not evident.

Findings suggest that consideration of mutual exchange transactions and benefits extend to *all stakeholders* within the network, rather than simply new technology companies. Findings show that sponsor membership retention within the network remains high despite a lack of direct evidence of 'deal flow', with other benefits, notably knowledge value identified as important to sponsors.

But sponsors, it is argued, have developed strong intermediary ties with Connect because of a commitment of social capital as more permanent entities within the regional community. Sponsors are amongst peers, colleagues and competitors that together provide a level of corporate citizenship in support of regional technology entrepreneurship. These findings lend support to Zajac and Olsen's 'joint value maximisation principle' and the notion of collective value in explaining sponsor retention in the network.

Success of Connect's multi-stakeholder constituency is contingent on maintaining a relatively stable private and public sponsorship base. This sponsorship base provides a level of '*embeddedness*' (Granovetter 1982), that reflects established social capital, resources and capabilities available in the network in addition to the role of Connect in facilitating exchange and generating an appropriate flow-through of technology companies.

12.2.3 Network Management

Connect *manages* what network theorists argue is the fundamental benefit of networks - the linkages and contact among people and institutions that provides opportunities for exchange of valued resources, including information, knowledge, skills, expertise and investment (Starr and MacMillan, 1990). As mentioned earlier, Connect's formal *network governance* activities began with identifying the *attributes*

of each stakeholder category (private sector sponsor, university, technology company, others) and promotion of explicit benefits that would attract them to the network.

Findings show that knowledge quality, relevance and newness delivered through ongoing event topics by Connect attracts and maintains the multi-stakeholder constituency. By gathering different communities together, Connect creates an "integrated learning environment". But Connect staff at events also play a role in stimulating 'connections' among and between stakeholders through introductions. Indeed, this role is played also by 'regulars', those long-standing stakeholders that welcome new faces to events.

Findings support a transactional economics argument that Connect's 'intermediary role' reduces the overall cost of search for individuals seeking resources and capabilities and for institutions and overall stakeholder communities at the regional level supporting technology entrepreneurship (Casson 1997). A value for money assessment in Chapter Eight identified a low overall cost to managing the network. Comparison of these costs with other support agencies, technology transfer offices and professional development courses suggests Connect is good value for money in return for these multi-stakeholder benefits.

Further, the identified impartiality and political neutrality of Connect with its stakeholders creates a bond of trust that facilitates linkages and exchange between institutions and individuals that may not otherwise interact at this level.

An ongoing program of *recurrent events* reinforces interaction, knowledge transfer and reciprocal value exchange between and among this multi-stakeholder constituency. Connect's recurrent events can be thought of as channels for *migratory knowledge* (Badaracco 1991); knowledge that is easily transferable within a region to various locations (Aberdeen, Dundee, Edinburgh, Glasgow) and to a similar stakeholder audience.

Replicating this knowledge transfer mechanism to four locations in Scotland provides a *representative linkage* (Eisenberg *et al* 1985) for Connect in promoting the network but also creates consistency of information flow throughout the region to similar categories of stakeholders, i.e. sponsors, universities and technology entrepreneurs and companies.

Each of these regional events, involving a similar stakeholder audience mix, provides a level of *institutional linkage* (Eisenberg *et al* 1985) where information and potential resources and capabilities are exchanged without the involvement of the same representative personalities. Stimulating institutional linkages is an essential element of Connect's mission, particularly between research institutions and industry, that is reflected in event objectives and participant 'mix' targets. Indeed, stakeholders confirm collaboration is being stimulated among institutions at events through the development of client, service provider and partner contacts.

Feedback from university spin-out companies identify the importance of *personal linkages* rather than institutional linkages in representing their own potential commercial interests at recurrent events and the ability to socialise with people external to the university. Indeed, university case study respondents identify the importance of external advice, contacts and knowledge obtained from people other than institutional technology transfer personnel, also in attendance at events.

Findings suggest that the ability of academic entrepreneurs to bypass university technology transfer offices as a first port-of-call is perceived by some universities to undermine their control of commercialisation efforts, and is among the factors seen to contribute to a weak linkage between some universities and Connect.

Developing individual social capital as a new entrepreneur is particularly important in the Scottish context. Technology entrepreneurship is highly concentrated geographically in the 'Silicon Glen' corridor, a 45-minute drive between Glasgow and Edinburgh, and this close proximity breeds familiarity among innovators, entrepreneurs and young companies.

As well, the small number and proximity of service providers and investors means that many of these people know each other through professional contacts. Dense social contacts among those ‘holding resources’ highlights the importance of ‘who you know’ in Scotland. Newly emerging entrepreneurs in the Scottish commercial scene, it can be argued, possess little power and legitimacy to engage in exchange activities until they can leverage an adequate level of social capital (e.g. Sharman *et al* 1991; Cooper and Folta 2000).

Managing an appropriate *mix* of stakeholders to stimulate multi-stakeholder exchange is a primary network management role. Already identified are benefit expectations by all stakeholders within the network that creates a level of *reciprocal value exchange*, dependent on a balanced mix of stakeholders at events. For sponsors and investors, identifying promising new technologies and business proposals is available with the presence of scientists and academic entrepreneurs at events from all Scottish universities and most research institutions. Conversely, access to relevant expertise and experience for ‘intelligent selection’ and for successful mentoring is available for those forming new companies with the presence of public and private sponsors, university technology transfer personnel and individual members.

Strengthening Connect’s network intermediation role is a ‘unique selling point’ distinguishing Connect from other networks and most other agencies. Connect takes an active role in linking technology companies with investors through its investment events that generate significant *tangible and intangible benefits* (identified by 80% of respondent companies). This role provides Connect with high community visibility and credibility among sponsors and policy-makers. The Investment Conference benefits from a first-mover advantage as a national investment forum devoted exclusively to high-potential technology companies without bias to technology sector. Indeed, the Connect concept and global network is promoted through the Investment Conference with the presence of an international investor audience.

The demise of investment in 2002 for technology sectors in general was reflected in overall low levels of investment generated at the Investment Conference, demonstrating the significant effects of market conditions for entry of new technology companies (Learned 1992; Audretsch 1995). However, investment survey findings in Chapter Eight identify that under these conditions, Connect investment events play a key role when technology sectors experience economic down-turns resulting in shifts in commercial interests from one sector to another.

Connect sponsors and members stress the importance of Connect as a dedicated forum for ongoing technology promotion that can ride out volatile market conditions and allow prospective new companies to be identified and social relations developed that can accelerate entry into the market once sectoral conditions improve. Findings also identify the importance of recurrent events in providing initial social contact between local investors and those involved with emerging technology opportunities prior to the Investment Conference that can also speed up the investment process.

12.2.4 Network Benefits and Value Flows

Findings after five years identify that the most important network benefits for all stakeholders are social networking opportunities among institutions and people, delivering high-quality business-orientated knowledge and preparing and exposing promising technology companies to investors.

Findings identify that this social value is evolving from social ‘business-inclusion’ indicators of ‘meeting interesting people’ and ‘feeling part of a network’ to more ‘business-generating’ social indicators of ‘meeting potential backers of one’s idea’ and ‘receiving valuable advice’. These findings show the Connect network is *improving* the level of social capital developed regionally and the quality of social exchange between entrepreneurs, investors and others and the provision and receiving of valuable financial information.

A key finding identifies that gaining investment within the network is strongly correlated with development of positive social relations. This suggests that established social ties provide the atmosphere of credibility and trust that are considered prerequisites for knowledge transfer and development of business relationships that include securing investment. Introductions by third parties, identified in case studies, is an important factor in establishing contacts with investors at recurrent events and being introduced to new business prospects.

The above findings may explain the relationship between the low levels of university financial and social value identified in the 1999 survey and the dramatic increase in social value by universities in 2001. Perhaps technology transfer personnel are consciously more actively engaged in social interactions leading to investment in 2001. However, another factor contributing to low university perceptions of financial value may involve the attitudes of investors to universities. Stakeholders identify that certain Scottish universities are difficult to deal with, e.g. over-valuing their technologies or seeking unrealistic partnership terms, suggesting that investors may be more attracted to technology opportunities outside university control.

Financial and knowledge value flows have significantly increased in the second survey to support network evolution literature suggesting that social interaction and acquaintances tend to precede exchanges and collaborations involving resources (Larson and Starr 1993). Knowledge value for sponsors and universities are particularly highly rated and findings identify that sponsors explicitly utilise the network events as an informal educational forum for staff and to remain up-to-date on technology knowledge.

The emerging role of 'individual' stakeholders, many identified as angel investors, is increasing the level of financial value flows within the network. Personal investments are occurring alongside public seed schemes and professional venture capitalists, facilitated by early knowledge of and contact with emerging technology opportunities identified through network participation (Mason and Harrison 1996).

Findings do not support literature suggestions that would imply the Connect network evolving towards more strategic interactions (Butler and Hanson 1991) primarily because networking activities are not between existing companies but rather among supportive agents and emerging technology opportunities. This ongoing 'boundary' of network evolution relates to the intermediary role of Connect in facilitating social, knowledge and financial value focused on new companies. Findings identify successful companies exiting the network, having identified Connect's diminishing relevance to them in a more mature stage of growth.

12.2.5 Evolving Network Management Model and Effects

Findings identify various 'change drivers' that resulted in the decision by Connect directors to pursue a private sector network management model after six years as a university-based, primarily publicly supported program. The desire for greater autonomy over its activities, bureaucratic constraints of university administration, perceptions of Connect as an Edinburgh University program and risk of reliance on public funds were among the main reasons to leave the university.

A key driver for change was the perception by CEO Ian MacDonald and the Connect board that a regional support constituency was now developed, and greater value needed to be leveraged to realise the network's potential. This could only be achieved as a private company rather than a university-based program.

The network structure has increased in formalisation and standardisation, with activities by staff more performance-oriented and communication efficiencies provided by the Connect website. These changes reflect evolutionary stages of the firm (e.g. Mount *et al* 1993; Bhide 1999) whereby structures become more stable and formal over time. Connect is answerable to a professional board of directors that has created a tighter assessment of company activities on a cost-benefit basis.

An important question regarding the consolidation of the network is whether or not this is a self-imposed strategic limitation based on the discrepancy between Connect's original intentions and their realisation. Maintaining a high level of relevance across technology sectors has been challenged by Connect's limited resources. Feedback from 2001 stakeholders clearly identifies growing concerns among certain sectors regarding a focus on certain sectors, e.g. software that comprises the highest proportion of members. Positioning Connect between universities and industry has not been fully realised in part because of university perceptions of Connect as a threat and the absence of industry linkages available for collaboration.

Increasing value provision in return for higher membership fees has resulted in changes to how Connect deals with sponsors and companies. Connect's role as network manager has evolved from one of 'facilitation and encouragement of interactions' among regional support agents to a more active role in 'mentoring and intermediating', in particular between sponsors and new technology companies.

To provide greater value to its company members, Connect has adopted a '*lifecycle format*' for its events in an attempt to align knowledge topics to new companies as they evolve through their formation processes. Indeed, Connect has worked with the Proof-of-Concept Fund to co-ordinate joint activities on behalf of emerging technology project arising out of the Scottish Universities. The advantage for sponsors with this format is to identify where companies are in their formation processes according to events they attend.

For sponsors, Connect is attempting to identify and attract high-potential technology companies with the logic that sponsors seeking these high potential clients will be attracted as well. However, one concern with this approach is predicting the potential of a new company to survive and grow as no one factor offers a predictive technique (Storey 1993).

Without a reasonably accurate basis for being selective¹, it could also be argued that it is difficult to differentiate between needs for support and assistance on behalf of the new company (Horne *et al.* 1992: 65). The volatility and uncertainty of technology sectors, suggested by membership retention data, shows that Connect cannot confirm to sponsors from one year to the next the level or quality of technology company membership. However, an advantage of Connect in this regard is that the network accommodates companies from a cross-section of technology sectors, although this provision is challenged as discussed earlier.

Findings suggest that increasing selectivity to high potential technology opportunities and preoccupation in ensuring sponsor client flow could compromise network stakeholder mix and reciprocal value exchange. Using Granovetter's theory of network ties (1982), people with '*weak ties*' are less likely to be connected to others, or are embedded in a structural hole. Although a disadvantage of weak ties is lack of access to 'network flow's of information and exchange opportunities, an advantage of weak ties suggested by Granovetter and Burt is that information obtained from weak ties is more likely to be unique and less likely to be redundant. This *diversity of information* from weak ties is used to explain the introduction of innovations into organisations.

The implications of structural holes and weak ties for Connect relate to Connect's membership structure and the level of inflow-outflow of new sponsors and members. In its previous business model to June 2001, Connect allowed for an 'other' category of network participants to derive value from the network without a corresponding membership commitment. Inflow and outflow of participants to events was relatively unrestricted, the former influenced by expected benefits and the latter by the degree to which these benefits were realised.

¹ Venture capitalists and other investor members of the network undertake this role but remains a high-risk activity even for these 'selection specialists'.

Loss of scope of information and knowledge available within the network could affect the level of *intangible benefits* flowing between and among a broad array of stakeholders. Loss of intangible benefits may result in two possibilities. The first is a loss of what Granovetter suggests is unique and non-redundant information from weak ties between people. The significance of intangible benefits is shown in the variety of social, knowledge and financial value flow benefits deriving from stakeholder exchange.

The second possibility is that other support programs emerge to fill this gap. Indeed, arguments could be made for a 'new' informal network based on the notion of Granovetter's weak ties and distinctions between formal and emergent networks by Aldrich (1976) who suggests that naturally occurring networks capture more of the important aspects of communication rather than imposed or managed networks. Another possibility, identified by Dr. Keith Winton of Edinburgh Technology Fund, is that other support initiatives will accommodate this need, much like Connect has done to support university spin-outs.

These findings counter Butler and Hanson's suggestion that networks are highly dynamic, the results of interchanging actors and knowledge. The Connect network, in fact, is becoming more stable with pre-selection of matched sponsors and members and formal knowledge intermediation. The potential loss of unscheduled attendees and non-members dropping into the network, a more selective network entry process and greater efforts to retain fee-paying sponsors runs the risk of losing dynamism in flows of information, knowledge, resources and capabilities associated with non-redundant network actors (Aldrich 1976; Granovetter 1982).

Further evolution of Connect's network management role could result in a 'threshold crossing' whereby stakeholders and indeed private sponsors identify Connect as a consulting company incubating new technology companies. This would compromise its 'arms-length relationship between academia and industry in Scotland and would constitute a 'conflict of interest' with its private and public sector sponsors.

Findings suggest that a key challenge for Connect remains to ensure the right mix of people to fulfil these objectives and ensure a balance of altruistic outcomes on behalf of entrepreneurs and new companies on the one hand and business-generating outcomes on the other hand. The potential loss of intangible benefits within the regional network is highlighted again as a key concern with Connect's new network management model.

At the same time, Connect's core competencies and critical success factors remain despite the change in its network management model. It takes a medium to longer-term view of support for technology entrepreneurship and provides a progressive forum to support commercialisation efforts of new technology companies that leads the best of these companies to present at the Investment Conference. Similar to evolutionary stages of the firm, Connect demonstrates an ability to adjust and adapt to changing external circumstances on the one hand and needs of its network constituency on the other. Connect continues to remain remarkably clear of political overtones in what can be argued is a politicised support environment in Scotland.

12.3 RESEARCH QUESTIONS ON NETWORK EFFECTS FOR TECHNOLOGY COMPANIES

The second set of research questions relates to technology companies. What specific commercialisation difficulties are faced by new technology companies in a particular region that justifies the need for support and how can benefits be identified and attributed to involvement within the network? Are benefits of a network-based support initiative similar to network benefits identified in other studies, e.g. social capital effects, knowledge transfer, business credibility, access to resources not held internally, etc?

12.3.1 Commercialisation Challenges for New Technology Companies

Case studies identify specific issues facing Scottish technology companies and insights into the justification of Connect and other complementary support initiatives. Accepting the differences caused by diversity in core technology, the lessons to be derived from the formation of the six case companies are remarkably similar:

- ❑ All companies started from the position of possessing a technology that was innovative but was in the relatively early stage of a fully developing marketable product.
- ❑ Initially there was a crucial role for typically one or two individuals, who having perceived the opportunity, remained the 'driving force' behind the project until, at least, other professional staff were brought in who could share in and contribute to the realisation of this vision. The strong socio-psychological characteristics of company founders were identified as critically important in countering constraints, investment gaps and institutional issues when dealing with universities over ownership.
- ❑ Teambuilding was initiated early by some founders based on their perceived commercial and technical limitations, while for others, it was externally initiated as a pre-condition for investment. Either way, teambuilding was identified as a vital part of each company's growth success.
- ❑ Technology development and commercial development were identified as simultaneous activities; one cannot be ignored while focusing on the other. Particularly for biotechnology companies (Yaba and ExpressOn), pressures to verify technologies, identify markets, secure customers and secure funding from a select group of potential investors made managing formation and growth processes more challenging to founders.
- ❑ By spending time developing a suitable core technology, companies were able to customise their products for individual niche market places relatively quickly.

- ❑ Early stage or 'seed' funding was relatively easy to obtain, although the negotiation and filing procedures caused delays. Later difficulties arose when technological 'milestones' were not being achieved.
- ❑ Particularly when private investment was involved, companies needed to pay careful attention to developing a clear and realistic relationship between themselves and their financiers, concerning what is obtainable in the short-term, necessary in the long-term and what they were giving up.
- ❑ When challenged by investment delays or technological difficulties, these successful companies demonstrated an ability to objectively reflect upon their long-term strategic direction.
- ❑ In the early stages, each company was sensitive to the importance of developing informal social relationships as a way of establishing credibility in the business community and seeking new resources; this prompted them to join Connect.

Case companies reflected high variation in approaches to seeking investment and the use of investment mechanisms, although public schemes are a common feature of early stage funds. Access to seed funding was not a constraint for all six case companies, with SMART awards and ETF the predominant seed schemes used by university spin-outs.

The funding gaps were significant between seed funding and second and subsequent rounds of funding for case companies. These funding gaps delayed for most of the case companies development of their core technologies into new applications and products, threatening at least in the minds of founders their perceived 'first-mover' market advantage. In some cases, further technology development was a necessary condition in attracting further investment but for other companies, it involved foreseeing the need to protect an existing market position.

Findings reveal that opportunities to exploit the innovation were constrained primarily by commercialisation difficulties. For companies without commercial skills, access to investment came with stringent conditions to reduce risk, resulting in tight target milestones and loss of ownership and some control, as was the case for

ExpressOn in securing venture capital investment. Another commonly cited investor requirement was to bring in experienced managers. Stakeholders also identify the constraint in Scotland of finding experienced managers and securing this level of expertise. Indeed, gaining access to experienced commercial specialists was expressed by companies as a key reason for joining Connect.

Findings identify various problems in the development of clear and mutually supportive relationships with venture capital investors, supporting Bullock's (1984) observation that a constraint in spin-out formation is the ability of the financial and business services community to understand and support young advanced technology enterprises. Particularly for biotechnology companies, Yaba and ExpressOn, a longer perceived risk-return horizon required these companies to develop their technology further to appease investor concerns. Indeed, a suggested limitation in regional investors interested or knowledgeable in biotechnology required these companies to undergo greater scrutiny and due diligence than the other case companies.

The introduction of private investment was identified by companies as a point where founders reflected on what they aspired to achieve from the company in light of investor expectations. This required developing a clear and realistic relationship between each of the parties, concerning what is obtainable in the short-term and necessary in the long-term. Indeed, for founders of Yaba and AXEON, such a period of reflection was identified as crucial for the clear and successful strategic development of the company.

Challenges in securing IPR from universities tainted somewhat the initial support received and compromised the building or maintenance of strong relationships between the spin-out company and university. Most significant is the apparent dual role performed by technology transfer offices, on the one hand providing advice and support in contract research but shifting to an adversarial position on the other hand once discussions of ownership commence. Findings suggest inherent problems in

the processes and procedures between some Scottish universities and their commercially active scientists to transfer ownership and form new companies.

Despite the assertion by various university technology transfer respondents that “*we take the primary role in forming spin-out companies*”, findings show that spin-out companies ‘engineer’ their own formation processes, beginning with disengagement activities to leave the university. Five of the six case companies examined were either spin-out companies from Scottish universities or drew heavily from them for their core technology and staff.

The six case companies represent active attempts to engineer their own ‘support constituencies’ that reflects their vision of the market opportunity. This vision ranged from a high-risk strategy undertaken by a ‘stereotypical market intermediary’ motivated by profit (AXEON) to a lower-risk strategy by academic entrepreneurs who gradually transferred their efforts into forming a company, after careful cost-benefit analysis and an external verification of the value of the idea (Intrallect).

However, a *pre-conceived* search for resources and capabilities suggested in the literature does not explain how case spin-out companies have used the Connect network. Each of the four university spin-outs were not created with the original objective of bringing together diverse resources and capabilities but were explicitly mobilising a wider range of resources as the viability of a new company became more apparent.

The use of ‘*sustaining strategies*’ points to a trade-off dilemma, where founders have determined to exit the university, but cannot until it is economically viable. These strategies were undertaken to ‘survive’ between seed funding and subsequent investment and involved maintaining academic positions, pursuing contract research and identifying and securing other public funding schemes. These sustaining strategies are suggested in Bullock’s ‘development path of risk’ model (1984) of MIT spin-off companies that use consultancy work for cash flow, to acquire specialised knowledge on clients and acquire business experience in early stages. In

the case of AXEON, these strategies were not available; therefore the company diversified its investment sources in early formation to include personal savings, debt capital and various private investment partners.

12.3.2 Network Benefits to Companies

Case study findings lend support to Sedaitis's view (1997: 142) that "*the founding network reproduces itself in the organisation it creates, facilitating a different type of organisational structure and strategy*". Connect facilitates, in the Scottish context, technology-based companies that may not necessarily be identified as 'alternative to markets and vertically integrated companies' but nevertheless display an adoptive strategy of resource acquisition facilitated by the Connect network.

Taking case company *Expresson Bio-systems Ltd* as an example, the following commercial activities and primary contributors reflect a network process:

- ❑ Initial company formation advice - Connect
- ❑ Initial legal structure – University of Edinburgh
- ❑ Initial Plant and Equipment – University of Edinburgh
- ❑ SEED Funding – UK Enterprise Challenge (Edinburgh Technology Fund)
- ❑ First paid salary – RSE Fellowship
- ❑ Business knowledge – Connect
- ❑ Second round investors identified – Connect
- ❑ Business premises – Roslin Biocentre
- ❑ 2nd and 3rd round financing – Venture Capital Consortium

Connect has provided for ExpressOn, in essence, an active intermediary role whereby people were identified and recommended that would be appropriate to company formation requirements as this requirements emerged. The host universities did not *consistently* play this role for ExpresssOn or for the other three spin-out companies. Rather, it was identified that university efforts became more

focused on securing a return on the technology as it became apparent that a company was attempting to spin-out.

For spin-out companies and particularly academics with little commercial experience, an additional challenge to technological development is the challenge of forming a new company at the same time. Connect was identified as providing the greatest value in commercialisation support by providing case companies with the opportunity to search, filter, assimilate and integrate knowledge from a variety of sources through network participation. In effect, 'transaction costs' of reputation building and the learning curve are subsidised through their access to Connect's established and credible network and ongoing network activities. Connect reduces the 'search' by technology companies for technological and business knowledge and access to skilled labor for companies undergoing growth as identified by Spektra.

Collaboration between new companies and other stakeholders in the Connect network is motivated by the differential distribution of resources and capabilities available among stakeholders in the network and those being sought by these new companies. The uncertainty of company viability in the early formation processes is related to the notion of 'commercialisation as an interactive learning process' (Asheim and Cooke 1999). This process is associated with a complex and continually changing array of both technological opportunities (and threats) and market opportunities (and threats), linked to patterns of new product development, commercialisation and adoption/diffusion.

These findings suggest that Connect supports 'accelerated learning' amongst its technology companies. The ability of emerging technology companies to continuously adapt their core technology to evolving markets or investor requirements, to explore and build partnerships with other technology developers, to make informed assessments of available sources of investment, to find specific sources of advice on the managerial development of their companies and in general to fill critical gaps in their own knowledge have been enhanced by Connect (Oakey *et al* 1990; North and Smallbone 1996; Malecki 1997).

Case companies demonstrate the need for “*mobilisation of a team of different competencies*” and Connect is identified with facilitating the building of these competencies. Connect facilitates network benefits indirectly to new technology innovations and companies that are ‘immersed’ among supportive resources, with the network, similar to a locality, a nexus of ‘relational assets’ (Storper 1997). In identifying and attracting a variety of supportive agents to the network whom possess relevant knowledge and resources, Connect makes the network attractive for new entrepreneurs and their technologies while stimulating the exchange of information, knowledge and other resources among other stakeholders.

Case companies also identify Connect’s value in facilitating transitions towards more formal business management processes, encouraging knowledge provision, sharing experiences and identifying those with necessary resources and capabilities, rather than simply providing services in response to demand, characteristic of other complementary initiatives.

Findings identify that for technology companies, Connect provides the most value during early formation activities and that this value lessens over time. Case company Spektra, for example, identifies the ‘*gradual diminishing value*’ of Connect as company growth and evolving challenges necessitate new skills and resources that pushed staff to seek other forums and networks. All three Directors of Spektra identify steep personal knowledge curves whereby information and knowledge on forming companies was appropriate and readily absorbed as active participants of Connect events. Company credibility and reputation building was also critical in the early stages of their involvement with Connect, but these directors concede that they have moved on to become members of other support communities.

12.4 RESEARCH QUESTIONS ON CONNECT AMONG OTHER INITIATIVES AND REGIONAL FACTORS

The third set of research questions related to Connect as one support initiative among others within the region. What is Connect's support role among other identified complementary support initiatives and how do they operate as elements of a National System of Innovation (NIS), or more specifically, a regional system of innovation? What external factors are evident that directly affect intervention and support in the region?

Consideration of the Connect network as part of a regional or national innovation system (NIS) suggests that Connect is interconnected with other institutions that jointly determine the generation and diffusion of technologies. Although measuring the efficiency of a Scottish NIS is difficult and beyond the scope of this research, Charles *et al* (2000) identify challenges of evaluating a regional innovation and technology transfer strategy that include *overlap* among service suppliers. They further suggest that an evolutionary view of evaluation emphasises relative rather than absolute impact changes or *how far* have improvements been made from a starting position rather than *how much* impact was achieved.

In consideration of pre-conditions for technology entrepreneurship prior to Connect Scotland, what has been identified in this research are pieces of evidence showing Connect's role in facilitating interactions between elements of the Scottish innovation system. Already discussed has been facilitation of social, knowledge and financial value among institutional and personal linkages within the Connect network.

Since Connect began in 1996, Scotland has developed an investment community that includes a more pro-active angel network, more venture capital funds and a greater willingness from both formal and informal investors to provide investment advice to new entrepreneurs and start-up companies. This effect has occurred in response to investment and new company successes, particularly high profile new Scottish

companies such as Spektra and AXEON. Connect's Investment Conference has emerged as the pre-eminent technology investment conference and is complemented by the recurrent events facilitating many of the social and knowledge values leading to investment opportunities.

Findings identify growing competition for young technology companies by increased investment available and at the same time, a growing knowledgeable and assertive community of new technology companies, scientists and entrepreneurs that understand the value of their technologies. Indeed, the research found evidence that the quality of individual technology start-ups has improved in Scotland through the efforts of Connect and complementary initiatives. The parallel development of seedcorn funding through the Proof-of-Concept Fund, ETF and RSE Fellowship Scheme has influenced this trend. Survey and case results demonstrate that knowledge of technologies, their commercialisation and the profile raising of various technology sectors have been advanced through Connect.

Multiple points of entry and confusion over features and benefits of various support initiatives available in Scotland point to the absence of synergy among complementary initiatives in support provision that continues to challenge Connect and Scottish policy-makers in general. This is not a surprise, given that each of these initiatives has emerged within a particular socio-political context. Creating a co-ordinated and integrated set of support initiatives would involve the restructuring and integration of these services at one level and acceptance by various institutions and agencies of an integrated support system. Yet, stakeholders argue for the need to clarify the boundaries between these initiatives and Connect and the attributes of each complementary initiative within an integrated support environment.

Findings already point out that Connect provides a transition environment for companies over time as they develop commercialisation competencies. This role contrasts with the provision of complementary support initiative benefits that are finite, time-sensitive and measurable, for example, the RSE award, SMART award,

ETF fund or POC fund, and that enable development of specific commercialisation competencies.

The co-ordination of complementary initiatives is gradually occurring, most recently between Connect and the Proof-of-Concept Fund and Connect and the Scottish Institute for Enterprise (SIE). The identification of Connect as a neutral forum and a hub for other complementary initiatives suggests that Connect could be promoted as a first port-of-call for young Scottish technology companies, conceding that university spin-outs would first contact their technology transfer offices.

However, an important factor in any attempt to co-ordinate a Scottish NIS is the strong ‘paternal’ role played by Scottish Enterprise in regional economic development and its tendency to create new programs and initiatives without direct collaboration with non-agency bodies. The role of SE with other support initiatives and the transparency of its provision of value require further examination and discussion.

Connect stakeholders argue that Connect must ride out the challenges in the technology sector, not stagnate and continue to leverage Connect’s brand and their new tag line “fast-track for technology business”. Returning to the original justification for Connect Scotland, findings substantiate that Connect has made a difference in reversing earlier claims that for Scotland, compared to successful technology regions, knowledgeable investors and access to commercialisation specialists were underdeveloped (Scottish Enterprise 1996).

Connect’s future collaboration possibilities are linking with global complementary initiatives in the US, UK, Sweden, Norway and Denmark that all share a common ethos but have no formal links between each other. Connect Scotland in the future may take a leadership role in integrating the Connect network so that resources can be leveraged to support geographically-diverse technology companies. The branded Connect Scotland website is expected to also provide a portal for investment interaction among the Connects in the UK – Scotland, Warwick and Yorkshire.

12.4.1 Regional Challenges

Findings suggest that the Connect network and various complementary initiatives comprise some but not all of the key elements identified by Van de Ven (1993) as comprising an ‘entrepreneurial infrastructure’. As Van de Ven cautions, “*while entrepreneurial infrastructures are critically necessary, such mechanisms-once in place-are not sufficient conditions for fostering the development of commercialisation of technological innovations*”.

One challenge remains a weak entrepreneurial culture in Scottish society and among its research institutions in particular. Findings suggest that stimulating academic entrepreneurship, despite the focus by Connect and SIE on science students, is constrained by a UK research tradition based on published research as the cornerstone for advancement and career reputation. Despite the high volume and quality of science and technology knowledge creation in Scotland, the impact of Connect and other complementary support initiatives on technology entrepreneurship cannot possibly overcome shortcomings in entrepreneurial climate both within knowledge creation institutions and in the regional community in general (Malecki 1997).

Indeed, overcoming regional shortcomings requires inroads into a number of areas identified in this research. One factor constraining development of a supportive regional infrastructure for technology entrepreneurship is the weak *university-industry linkages* in Scotland that has shown little evidence of improvement during the course of this research. Economic data shows that Scotland’s uptake of university innovations by SMEs and corporations are among the lowest of UK regions. Indeed, this thesis argues that policy-makers in Scotland have not provided an integrated long-term vision to develop the ‘demand pull’ capacity and capability of Scotland’s technology-based industrial structure with the ‘technology push’ knowledge creation side already identified as strong.

The question of whether the requisite ‘critical mass’ of particular knowledge and expertise can ever evolve in the Scottish region, regardless of the activities of Connect remains a critical issue. Connect San Diego Co-Founder, Mary Walshok, cautions that university-industry partnerships require a policy environment supportive of economic growth and consistent with the regional infrastructure.

Findings identify sources of problems on the university side of the university-industry linkage. Connect spin-out companies that have dealt with technology transfer offices argue that the primary focus of universities is to maximise returns that can compromise the wider implications and economic potential of the technology. Most universities have created revenue targets and other output milestones that establish certain commercialisation practices that may not require or motivate active engagement with external commercialisation initiatives.

Findings identify concerns by senior directors of complementary support initiatives and other institutions regarding the potential conflict of interest of universities supporting their staff in exploiting university innovations. Indeed, the changing role from ‘*supportive to adversarial*’ is identified by case companies, resulting in negative experiences of securing ownership and perceptions of a general lack of support for forming new companies by some universities.

Survey findings show that universities demonstrate a low level of reciprocal value exchange that may be explained by their search for measurable benefits like investment and an acknowledgement by other stakeholders that universities are not seeking reciprocal value. Indeed, university perceptions of financial value remain the lowest among stakeholders. It is argued that further effort is required by Connect and its university sponsors to link the university environment with the commercial one in supporting new technology companies in Scotland.

Survey findings provide evidence that poor collaboration between new technology companies attempting to commercialise university technologies limits the creation of joint projects between industry and research universities. The experience of

AXEON, for example, identifies a 'dismissive' attitude by a number of Scottish universities when approached by an experienced entrepreneur like Hamish Grant seeking to licence university technologies.

Findings identify a gradual building process for technology entrepreneurship in Scotland that are linked to cultural and social change. Despite challenges previously suggested confronting Scotland's technology development, findings suggest that enthusiasm and support for technology entrepreneurship throughout Scotland has grown over the time frame of this research (1999-2002). At the same time, 2002 saw the demise of investment for high technology, and Connect's role of maintaining an active and supportive network is already identified as particularly important during economic downturns.

CHAPTER THIRTEEN

CONCLUSIONS AND IMPLICATIONS

13.1 THESIS SUMMARY

This thesis evaluated a regional support network for technology entrepreneurship in the United Kingdom, Connect Scotland, and examined the creation, formation, growth and impact of the network and its evolution from a public to a private sector model. This chapter concludes the thesis by first providing a summary then discussing its theoretical, practical and policy-related contributions, limitations and future research.

The research adopted the proposition that research on a regional support network for technology entrepreneurship requires a broad, multi-theoretical approach to the literature. Most appropriate were socio-economic accounts of technology creation and development, commercialisation and exploitation drivers, the role of the entrepreneur, collective action and risk-sharing, theories of enterprise creation and evolutionary phases of growth.

Broadly, the research identifies high priority given to technology-based entrepreneurship by public and private sectors – e.g. corporations, universities, regions and nations – to improve competitiveness, counter decreasing public funding support and diversify the regional industrial base, among other factors. High expectations are tempered by a myriad of suggested challenges to commercialising technologies and creating new companies to exploit these technologies. These challenges include volatile market conditions, high levels of risk, e.g. short product lifecycles and long time horizons for investment returns, high development costs and complexities in creating a marketable product.

This thesis takes the proposition that the spread of technological innovations and commercial success is a function of the support that innovators and entrepreneurs can

draw from other actors, the interactions among these support actors as well as industry conditions. The research draws upon national systems of innovation, agglomeration economies, studies of high-technology clusters and regional 'innovative milieu and entrepreneurial networks.

The research problem emerged in identifying market intervention for technology entrepreneurship, and in particular, regional intervention, where conditions and elements characterising successful technology regions like Silicon Valley are absent and must therefore be created and developed. *Connect Scotland* was chosen as a relevant case study to establish evidence of the value and impact of a regional support network in supporting technology-based entrepreneurship, with Scotland an appropriate region of study based on a strong science and technology base but identified low levels of enterprise creation and entrepreneurship. This thesis also focused on the relevance of network theory to regional networks and the role of the network among other regional support initiatives comprising a regional system of support.

The research defined Connect Scotland as a formal, managed network co-ordinating activities that draw institutional and individual actors to socially engage and develop relations that contribute to their own development, that of new technology companies and a sense of mutual obligation to regional development. Following a pilot study of Connect, the network was conceived as a *socio-commercial constituency* encompassing the interrelation and interactions between key players supporting the transformation of technological innovations into new enterprises. The pilot study also revealed attribution difficulties in measuring quantitative targets and identified the need to examine the network, its stakeholders and technology companies as units of analysis evolving over time within a regional support constituency.

This thesis adopted a participant-observation and action research design, identified as most appropriate when studying change and one is evaluating an intervention technique. Also developed was a constituency-building model to identify, describe and evaluate multiple components of the network, the interrelations and interactions

between them and changes to these components and processes over time.

This research approach examined factors contributing to the creation and development of the network since 1997 and network benefits and value as judged by stakeholders during this period. Six case studies revealed commercialisation processes and difficulties that informed the need for intervention, how network value was realised and drawn into processes of enterprise formation and growth and the effects of complementary support initiatives and regional external factors.

This thesis examined almost half of the Connect Scotland stakeholder constituency to establish conceptual, practical and methodological insights into the creation, formation, evolution, operations and benefits of a support network and its role amongst other initiatives supporting regional technology entrepreneurship.

13.2 CONTRIBUTIONS OF THE RESEARCH

In line with stated research aims and questions this thesis investigated a regional support network for technology entrepreneurship. In doing so, this work has made several contributions to the evaluation of regional support networks, network theory and insights into the creation, formation and evolution of support networks, practical insights into network management and policy-related insights into the role of networks in regional support and amongst complementary support initiatives.

13.2.1 Conceptual Contributions

This thesis has demonstrated the relevance of Molina's 'sociotechnical constituencies' model as it applies to describing and evaluating a regional *constituency* not so much involved in technical development as much as commercial development (Molina 1990). The fundamental conceptual underpinning of Molina's model is the dynamic ensembles of social constituents shaping each other in the

course of creating, producing and diffusing specific technologies. Moving further towards the market application of technological development, the model has been adapted in this thesis to refocus Molina's model to the social constituents creating, producing and supporting the 'transformation' of technologies into new enterprises.

Molina's model is complementary as well to the firm-level analysis adopted in this thesis by suggesting that conditions of commercial, technical and social uncertainty shape the motivations, interactions and choices of network engagement and translation of benefits from the network to the firm.

The constituency-building model addresses what Tichey *et al* (1979:507) describe as the key methodological challenge to evaluating business networks: "...a coherent framework and accompanying methods of analysis that are capable of capturing both prescribed and emergent processes". The constituency-building model and action research design demonstrates explanatory power and relevance in capturing the cumulative actions and diffusion effects of formal network management by Connect and the benefits for *all* its stakeholders that represent a regional depository of knowledge, capabilities and resources evolving over time.

This research found that a strong perception among stakeholders of Connect as a neutral social environment and the absence of a highly competitive external business environment diminishes competitive interaction, resulting in a more collaborative support constituency than perhaps expected in more dynamic and competitive economic regions. Molina emphasises that the balance between collaborative and competitive interaction will fundamentally affect the evolution and dynamism of the resulting sociotechnical constituency. The evolution of Connect to a private company may affect this neutral perception as the model takes on more characteristics of a consultancy.

As suggested above, Connect represents a conscious attempt to construct and manage a socio-commercial constituency rather than socio-technical one that first stimulates mobilisation of various support actors through a portfolio of knowledge, then

facilities the exchange of diverse capabilities through an evolving level of social engineering of constituents. Callon's Techno-economic network (TEN) concept within actor network theory emphasises successful mobilisation of scientific, technical and market actors and the distinctive 'translational' or intermediary interactions between them that contribute to supporting a socio-technical objective (Callon 1992). Callon emphasises that when translational interactions become more predictable and aligned, the network is more stability or 'irreversible' and quantification and black-boxing' of the network is possible.

Research finds that the Connect network is becoming more stable with pre-selection of matched sponsors and members and formal knowledge intermediation, countering the view that networks are highly dynamic, the results of interchanging actors and knowledge (Butler and Hanson 1991). The potential loss of unscheduled attendees and non-members dropping into the network, a more selective network entry process and greater efforts to retain fee-paying sponsors suggests the loss of dynamism in flows of information, knowledge, resources and capabilities associated with non-redundant network actors (Aldrich 1976; Granovetter 1982).

Connect's evolving network management model demonstrates, as Callon suggests, a more predictable and stable network whose structure and function is more predictable. Indeed, the emulation of Connect Scotland's model more recently to Warwick and Yorkshire in England suggests the 'black-boxing' of a network for duplication, with necessary customisation to suit regional conditions.

The thesis has identified that Connect's evolution as a support constituency is similar to evolutionary phases identified in theories of the firm (e.g Mount *et al* 1993; Bhidé 2000). Creation and formation phases are dependent on establishing early program credibility and a critical mass of prominent network participants particularly in a region where intervention and support are commonplace. This phase relies on the entrepreneurial drive and vision sharing to instigate formation processes and begin to build the programmatic constituency. Similarly, network growth has increased formalisation of procedures, performance standards for staff and accountability to a

professional board within the management structure. This thesis identifies that Connect as an increasingly stable constituency is selective in its value provision necessitated by a self-sustaining revenue model of network membership.

This research confirms the importance of ‘flows of value’ –social, knowledge and financial – that attract and maintain a constituency membership over time. These value flows have been shown to change over time, contingent on the mix of stakeholders engaged, accumulated institutional and individual embeddedness in the network, intensity of network management intermediation and economic conditions for the various technology sectors active in the network. The research identified that social value remains stable as the strongest perception by stakeholders of the network but that knowledge and financial value have proportionally increased over a two-year period.

This thesis confirmed that social capital is a precursor to knowledge and financial value exchange as hypothesised by Larson and Starr (1993), but demonstrates variation according to stakeholder value expectations and benefit experiences. A key finding identifies that gaining investment within the network is strongly correlated with development of positive social relations.

This thesis has identified that networks generate value flows among social constituents that can be managed by intermediation efforts over time. Evolutionary theories of networks suggest that actors mobilise their own capabilities and engage within various networks – informal and formal, social and business, technical and strategic, etc. – based on their resource and capability requirements that change over time. In the Connect network, value flows reflect a combination of self-managed exchange expectations motivating actors’ levels of social engagement and intermediated value provision in the form of technical and commercial knowledge provided by Connect that ensures social proximity of these actors.

13.2.2 Practical Contributions

The work forwards a definition of the regional support network Connect Scotland based on its structure and activities: *“an integrated and co-ordinated set of formal network activities that stimulate fee-paying institutional and individual actors to socially engage and develop ongoing economic and non-economic relations that contribute to their own development, that of new companies and a sense of mutual obligation to regional development”*.

The research shows that successful creation and formation of the Connect regional network cannot be attributed to any one factor, but rather reflects a *‘progression of key formation milestones’*. Clearly, an explicit and commonly shared consensus among key regional stakeholders - policy-makers, knowledge creators, the business community - that intervention for technology entrepreneurship is needed provides the *‘demand pull’* for such a program.

A key research finding shows that stimulating and sustaining a regional support network requires benefit provision to all stakeholders of the network, rather than simply new technology companies, in order to attract, retain and facilitate exchange between supportive agents that display low levels of interaction without intervention.

This thesis establishes the notion of *‘managed reciprocal value exchange’* that identifies the importance of Connect as a network manager that first of all explicitly creates expectations of network benefits to all stakeholders. Reciprocal value exchange motivates knowledge transfer between and among network participants with this exchange stimulated by network events and mediated by Connect’s directors and credible network actors providing introductions on behalf of new network entrants.

The research identifies an advantage of formal regional network management over informal and unmanaged networks in the provision of consistent, up-to-date and relevant knowledge delivered across the region to a diverse audience supporting

technology entrepreneurship. This thesis also found that network value is dependent on the right mix of stakeholders at events that facilitates the level and opportunity of benefit from knowledge exchange.

Findings show that meaningful and valued exchange between stakeholders is influenced by their perception of the network as a neutral, apolitical and effective social environment. This level of trust within the network has a significant impact on the level of value flow and sustainability of the network over time. Private sector sponsors and universities, for example, compete among each other in a small geographic region like Scotland, yet are all equal members within the network, where Connect aggregates a certain level of tolerance and equality among all stakeholders.

The thesis identifies stakeholder differences in networking behaviour. New technology-relevant knowledge acquisition motivates attendance to recurrent events by sponsors in particular, with the use of the network as a knowledge forum countering low levels of client 'deal-flow'. Commercial and business-related knowledge is being most sought by technology companies and to a lesser extent universities, with both these stakeholder groups actively seeking investors and the formation of business relationships. Findings identify low levels of reciprocal value exchange between universities and sponsors and universities and technology companies, suggested by a preoccupation by universities in seeking investors.

Findings suggest that technology companies use the network as 'discriminating consumers' and self-manage social, knowledge and financial provision within the network by engineering their own 'support constituencies' that reflects their vision of the market opportunity. Motivations for networking among case companies were primarily commercial rather than technical, beginning with the building up of social capital while formulating their commercial strategies. Lessons of case companies found that the lack of commercial resources and capabilities within the region rather than technical issues constrained formation processes of new technology companies.

The research found that Connect provided an ongoing supportive forum as emerging technology companies acquired and developed complementary resources and capabilities, unlike finite and measured 'commercialisation enablers' such as seed and proof-of-concept funds. The network remains available as a supportive environment as technology companies transform into different entities and benefit from the social capital they have already developed to leverage value from the network.

Research suggests that network management activities will leverage greater tangible benefits from the network in response to increasing the reliance on membership fees. Findings show transition from a facilitator role to mentor and intermediary of reciprocal benefits to increase value between sponsors and technology company members, suggesting an increase in network selectivity for high-potential clients and appropriate sponsors.

Findings suggest that potential loss of dynamic and unpredictable flows of information and knowledge, new actors, linkages and collaborations resulting from more exclusive network access may decrease the intangible benefits and non-redundant 'weak tie' benefits generated regionally and to existing network sponsors and members specifically. Less inclusion and more stabilisation could also hinder the formation of new networks resulting from Connect's need to ensure its prominence as Scotland's technology network.

This thesis identifies increasing collaboration and strategic alliances with other agencies by Connect, confirming a further evolutionary phase of maturing firms. One explanation is that Connect, in providing a more focused network model, has identified boundaries and thus its limitations on where it provides value. Another explanation is the increasing accountability of Connect to a professional board of Directors to identify all activities on a cost-benefit basis.

This thesis suggests that evolving preoccupation with network value provision to sponsors and members could result in a 'threshold crossing' whereby stakeholders and indeed private sponsors identify Connect as a consulting company incubating

new technology companies. This would compromise its 'arms-length relationship between academia and industry in Scotland and would constitute a 'conflict of interest' with its private and public sector sponsors.

This thesis suggests that one role of the network intermediary is to monitor its relevance and value to its stakeholders and adapt its events and activities on the basis of this information. Indeed, Connect adopted various recommendations¹ from the 'real-time' evaluation by a third party that has provided a level of objectivity and critical analysis. Network directors are ideally placed to gather feedback on an ongoing basis and effect change as required, and this thesis has generated data collection and analysis, survey, interview and case study tools that Connect can use to develop its own ongoing monitoring and evaluation process.

Findings suggests that the systematic monitoring and evaluation of Connect should also be undertaken in co-ordination with other technology-focused support initiatives, not only to benefit these programs and stakeholders but to create an openly accepted culture of evaluation.

Research found that overall, Connect is a successful regional support network that demonstrates flexibility and adaptation to change according to internal and external pressures without compromising its original mission and objectives, despite shifts in its value provision. It remains neutral and apolitical by bringing together independent resources, public and private, with the criteria being that the capabilities, resources and know-how are compatible with supporting new technology companies.

13.2.3 Policy Contributions

This thesis contributes several policy-related insights. First is the issue of commercialisation difficulties facing new Scottish technology companies. This thesis found that the 'business-forming conditions', rather than technology

development setbacks, were key constraints taking the form of administrative inefficiencies, unclear technology transfer policies and uncertain partner expectations.

Regional competencies to respond to technology development opportunities in a collaborative and timely fashion are shown to be weak. Despite the success to date of case companies, most identified pathway constraints arise from misinterpreting the technology and its market potential, disagreements over technology ownership, low levels of encouragement to start a company and funding gaps partly linked to risk-adverse investors and a lack of bio-technology savvy investors. This thesis suggests greater transparency by universities in how they support academics in enterprise creation. Indeed, this research suggests the need for explicit acknowledgement of the role of Scottish universities in economic development.

Research identifies multiple points of entry and confusion over features and benefits of various support initiatives available in Scotland. Removing commercialisation barriers requires a co-ordinated effort among complementary support initiatives that in fact should be delivered and operated effectively as part of a wider support network offering the fullest range of clearly demarcated services. This appears to be the role and responsibility of the national agency Scottish Enterprise.

Policy-makers should critically examine the ‘institutional inertia’ of Scottish Enterprise and the alignment of a myriad of public institutional objectives with the actual needs for support of technology-based entrepreneurship regionally. What is apparent from findings is the inconsistency of services that leave gaps filled by other agencies and an identified lack of trust among complementary support initiatives due in part to competition, real and perceived, from Scottish Enterprise. Indeed, there is an argument that each complementary support initiative be able to translate its objectives into activities and finally outcomes, benefits or value that can then be examined, co-ordinated and promoted at the regional level.

¹ Regular monitoring of event participation data, stakeholder feedback on network value, specific recommendations for event improvement and role among complementary initiatives, etc.

While it is conceded that social engineering of dispersed support initiatives and research institutions is a challenging task, much of the infrastructure to more effectively support technology entrepreneurship is already available. This thesis suggests the untapped potential to leverage existing 'commercialisation enabler' initiatives such as Proof-of-Concept, RSE Fellowships, SMART and ETF that are highly valued by new companies, and place them within a wider supportive delivery system.

Findings suggest the need for support mechanisms to be in the least co-ordinated through a common 'neutral reception portal'. Although Connect offers suitable characteristics for this intermediary role, this thesis argues that Connect is now 'part of the jigsaw'. Connect's recent transition from facilitator to relationship broker between sponsors and members suggests that this interface role may not be in Connect's interests as a private company, not to mention its stated frustration of operating within an 'integrated' Scottish support environment.

The thesis identified a direct regional economic development role played by the Connect network in attracting investment to the region and directly assisting promising new technology companies in becoming investor-ready. This thesis suggests that Connect is positively influencing conditions to support technology entrepreneurship by offering a consistent mandate of support, regional knowledge transfer, integrated intervention provision with complementary support initiatives and the stimulation of commercial agents to assist new technology companies.

This research suggests limitations to the regional economic role of Connect as a support network with the absence of any identifiable level of industrial actors, compromising the promise of developing a strong national system of innovation. With Scotland's industrial base becoming increasingly service-oriented, the explicit expectations by policy-makers of creating indigenous technology companies across various technology sectors appears contrary to what is actually transpiring.

13.3 RESEARCH LIMITATIONS

This thesis suggests that although Connect has been successful in increasing ‘connectivity’ between relevant constituencies responsible for supporting new technology companies, it is difficult to assess the degree to which this connectivity would have evolved in the *absence* of Connect.

One limitation of the research is that other similar comparable networks have not been identified. This thesis concedes that network participants are interacting among other support initiatives in the region and outside as well so a further question is the way these network participants co-evolve with and among other networks. One issue is defining boundaries when network members are also members of other networks and associations also generating social capital, knowledge and more tangible benefits. For analytical purposes, incorporating the network as part of a Scottish NSI would allow examination of the wider context of the environment in which new technology companies compete and are enabled or constrained.

Another limitation to the research is that the constituency-building framework and research design has focused on a particular perspective using a holistic point of view. The network in fact is constituted among the wider community but methodological considerations limited the evaluation of the wider regional support environment as noted earlier. However, this research approach has allowed for the partitioning of a complex area of study and established some limits to the research.

This thesis has also not tracked the outcomes of repeated network interactions and the development of relationships and collaboration has not been tracked. Indeed, the dynamic nature of relationships is assumed and value constructs of social, knowledge and financial value are accumulated from a historical perspective and provide an output measure of positive outcomes attributed to individuals, companies, stakeholder categories and the network overall.

Although consideration was given to follow the same stakeholder sample over two time periods to establish perceptions of value change, the issue of panel selection bias was considered. Those remaining in the network would be expected to state improvements. Further, due to the expected outflow of stakeholders from the network, loss of original samples would impact the rate of return and limit the success of a follow-up survey.

13.4 SUGGESTIONS FOR FUTURE RESEARCH

Various research opportunities are related to improving the evaluation methodology. Future research could be undertaken using factor analysis to examine the possible underlying structure in the social, knowledge and financial sets of interrelated variables of network value. Factor analysis would be used to confirm whether the indicators developed for each dimension (social, knowledge, financial) are related to each other. However, this level of analysis was not included in this research because the focus was on describing how stakeholder groups are distributed in relation to perceived value of Connect.

Another relevant area of future research is examining Scotland as a national system of innovations (NSI) through the constituency-building model, in which the NSI is placed at the centre of the model and elements are drawn out as a combination of regional, institutional, organisational and individual actors, activities, processes and mechanisms. This would assist in determining a regional pattern of support and a regional pattern of successful new technology companies, settlement and localising of companies, success or failures and growth outputs and evidence of clustering and industrial pattern changes.

An evolutionary approach to examining Scotland as a NSI, similar to this evaluation, would account for the expectations, perceived benefits and value flows between and among complementary initiatives and effects on technology companies. However, further evolutionary theory elements would be activated in studying growing

enterprises such as path-dependency, management systems, technology and market diversification etc.

Another research area of promise is to consider Birley's (1985) assertion that choice of networks is key in understanding the nature of companies. It is postulated that following up on Connect 'graduate' companies such as Spektra and AXEON could identify a 'next level' of company challenges, gaps and available opportunities for support.

The potential of adopting the evaluation methodology to other regions is already being explored. However, it is conceded that evaluating in another context requires a similar initial examination of network elements and processes prior to evaluation. Much interest has been expressed regarding the ongoing adaptation, improvement and use of a real-time, action research-oriented framework that provides both component and holistic evaluation possibilities and insights. Connect San Diego has expressed interest in adopting the evaluation methodology for the Global Connect Alliance. The Proof-of-Concept Fund is also interested in its application for evaluating developing technologies and their exploitation processes over time.

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APPENDIX A: NETWORK VALUE SURVEY



Participant Survey
(Fax return 0131 651 1778)

[This survey is part of research to monitor the evolution and impact of the CONNECT programme of activities. Your feedback will provide valuable information on the programme. Names of individuals and companies will NOT be associated with any information and comments provided in this survey]

(For reference only)

Participant Name_____

Organisation_____

Occupation_____

1. What is your affiliation to CONNECT? (Please circle)

Sponsor: Private/University/Public Company Member Individual Member
Non-Member Other: (Please state)_____

2. How many CONNECT events have you attended? (please circle)

Meet the Entrepreneur	1	2	3-5	6-9	10 or more
Enterprise Workshop	1	2	3-5	6-9	10 or more
Technology Briefing	1	2	3-5	6-9	10 or more
Springboard event	1	2	3-5	6-9	10 or more
Recruitment event	1	2	3-5	6-9	10 or more
Investment Conference	1	2	3-5	6-9	10 or more

3. How do you rate the overall quality of CONNECT events you have attended? (please circle)

Poor Moderate None Good Very Good Excellent

4. We wish to establish the benefit of your participation in CONNECT events for you or your organisation. Using the following scale below, please answer the following questions according to the rating scale below.

- 1 (not at all)

2 (to some extent)

3 (most definitely)
- 4 (not so far)

5 (not so far, but I expect to in the future)
- 6 (this question is not relevant to me)

SOCIAL VALUE		1 to 6
1 .I met interesting people who share my interests and concerns		
2. I feel part of a network of people for advice and contact		
3. I have established contacts with potential clients		
4. I have established contacts with potential suppliers of services		
5. I have established contacts with potential partners		
6. I met people looking to provide me with valuable advice		
7. I met people who will back and invest in my idea or product		
KNOWLEDGE VALUE		1 to 6
8. I have learnt relevant information for my business		
9. I have introduced my technology/product to a highly relevant audience		
10 I have learnt about new technologies/developments important to my business		
11 I have learnt about how to protect my intellectual capital (e.g., IPR, licensing)		
12 I have learnt new management and business skills		
13 I have learnt about training and support opportunities		
FINANCIAL VALUE		1 to 6
14. I have made good contacts with entrepreneurs		
15. I have made good contacts with investors; venture capitalists and angel investors		
16. I have <i>given</i> valuable financial information to a new business		
17. I have <i>obtained</i> valuable financial information		
18. I have learnt about the financial value		
19. I have invested in a new technology or product		
20. I have obtained financial backing for my product		

APPENDIX B:

SURVEY SAMPLING

Survey sampling is based on identifying two different stakeholder groups at two different times but who possess similar network participation experience and are likely to be the most informative about the value flows generated by the Connect network.

“Expanded Rings” Approach to Identifying Most Active Stakeholders

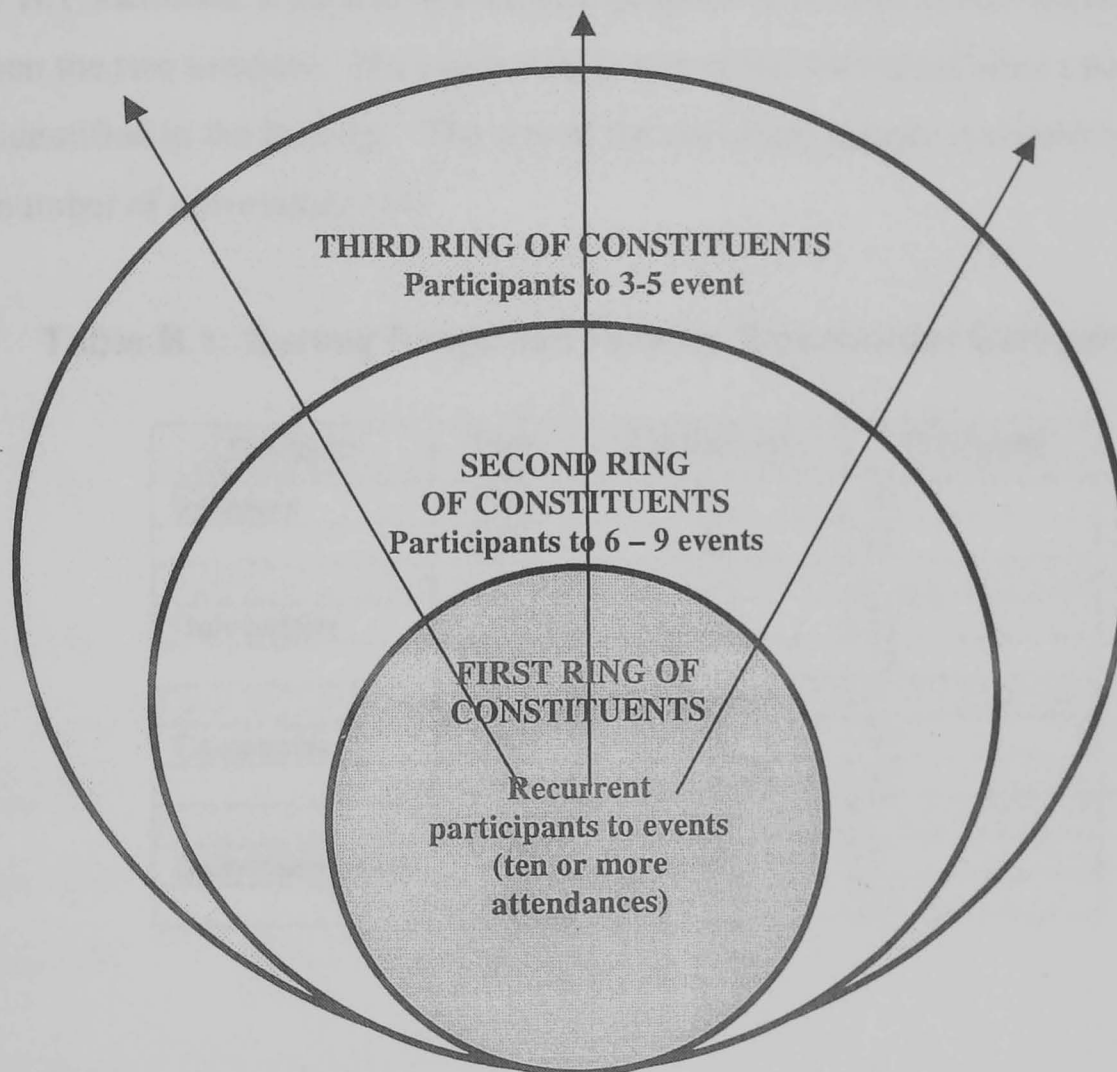


Table B.2 below identifies the relative similarity of network activity levels between the two samples. Most relevant is the higher levels of attendance (10 or more events) among the majority of the sample in 1999 and 2001 (46% and 57% respectively) and attendance to 6-9 events (33% and 35% respectively).

Table B.2: Network Participation Levels of Survey Respondents

Survey	Attendance to Events	Count	Percent
1999	3-5 events	13	20.9%
	6-9 events	22	32.8%
	10 or more events	31	46.3%
	TOTAL	67	100.0%
2001	3-5 events	4	8.2%
	6-9 events	17	34.7%
	10 or more events	28	57.1%
	TOTAL	49	100.0%

Table B.1 identifies a similar stakeholder proportion of stakeholder representation between the two samples. The small sample size of the individual/other category has been identified in the findings. The size of the university sample is related to the low total number of universities (14).

Table B.1: Survey Response Rate by Stakeholder Category

Category	Year	# of Surveys	% of Total
Sponsors	1999	14	20
	2001	10	21
Universities	1999	8	12
	2001	6	13
Companies	1999	45	65
	2001	24	51
Individual/Other	1999	2	3
	2001	7	15

APPENDIX C:

SEMI-STRUCTURED INTERVIEW SCHEDULE (1999-2002)

Date(s):	Interviewee	Interview Objective(s)
Oct, 1999, May 2001, June 2002, ongoing	Ian MacDonald, CEO, Connect Scotland	Creation, origins of Connect, network evolution, spin-out, complementary initiatives
Oct, 1999	Martin Ritchie, Former Chairman, Connect Scotland	Creation, origins of Connect
Nov, 1999	Janine Renton, Connect Private Sponsor	Value of network to sponsors, recommendations
Feb 2000	Jandy Stevenson, Connect Private Sponsor	Value of network to sponsors, recommendations
Feb 2000, April 2001, June 2002	Susan Morrison, Connect North Director	Network evolution, spin-out, complementary initiatives
Feb 2000, May 2001, June 2002	Andrew McNair, Connect West Director	Creation, origins of Connect, network evolution, spin-out, complementary initiatives
Oct, 1999, May 2001, June 2002	Gillian Mayman, Connect Director	Creation, origins of Connect, network evolution, spin-out, complementary initiatives
August 2000, Feb 2003	Mary Walshok, Connect San Diego	Creation, origins of Connect, evolution of Connect
June 2001	Gordon McAndrew, Sponsor and former Connect board member	Network evolution, Complementary initiatives
Feb 2000	Bill Cook, Connect Public sector Sponsor	Value of network, recommendations
November 1999, June 2001	Bob Smailes, Director ERI	University technology transfer
Sept 2001	Cathy Garner, Glasgow Research&Enterprise	University technology transfer
Feb, 2000	Pamela Symes, Scottish Enterprise	Complementary initiatives
May 2002	Keith Winton, ETF	Creation, origins of Connect, network evolution, Complementary Initiatives
June 2002	John Withers, Roslin Institute	Complementary Initiatives
Sept 2001, May 2002	Eleanor Taylor, POC fund	Complementary Initiatives
June 2001	Carl Togeri (SIE)	Complementary Initiatives
Sept, 2002	Professor James Fleck, Director, Edinburgh University Mgmt School	Creation, origins of Connect

APPENDIX D:

SEMI-STRUCTURED INTERVIEW FORMAT

The primary objective of the interview is to ascertain facts and details from the individual that contribute to a more thorough understanding of Connect. The interview methodology is intended to triangulate facts and perceptions from key players and stakeholders regarding Connect's inception, objectives, and deliverables with survey and case findings.

STRUCTURED QUESTIONS:

1. What was your **first contact** or experience with CONNECT?
2. What was your **initial impression** about CONNECT? (as a concept, as a viable program)
3. How has your **impression of CONNECT changed**; from the initial impression through to your impression today?
4. What do you feel are **key factors** that have allowed CONNECT to become established and accepted in Scotland?
5. Who do you feel are the **key people** making CONNECT work and why are they important?
6. What are your thoughts regarding the **primary intention** or mandate of CONNECT and what problems are being addressed by CONNECT?
7. Is CONNECT **achieving those intentions just mentioned by you**?
8. What are the **features of CONNECT** that make the program unique or distinct from other support programs in Scotland?

APPENDIX E:

SURVEY STAKEHOLDERS INTERVIEWED (52)

1999: n=36 (54% of survey respondents in 1991)

CATEGORY	COMPANY	CONTACT
Sponsor	Scottish Enterprise	Pamela Symes
Sponsor	KPMG	Jandy Stevenson
Sponsor	Grampian Enterprise	Tony Althous
Sponsor	(Grampian)	Helen Watts
Sponsor	Melville Craig Group	Niahm Donellan
Sponsor	WL Ventures	Kathy Greenwood
Sponsor	Ernst and Young	Janine Renton
Sponsor	Ayrshire New Venture Centre	Christine Fox
Sponsor	Dumbartonshire Enterprise	Scott Skinner Ritchie Malloch
Sponsor	Murgitroyd and Company	James Brown
Sponsor	Bird Semple	Chris Nicol Craig Stirling
Sponsor	Forth Valley Enterprise	Bill Cook
University	University of Glasgow	Moe Thuzar
University	University of Edinburgh	Ewan Chirnside
University	Napier University	Andrew Sijan
University	University of Stirling	Barbara Blaney
University	University of Aberdeen	Helen MacDonald
University	Glasgow Caledonian	Frank Bell
Company	Starttech Partners	Gordon Eadie
Company	Rowett	Shane Maloney
Company	AMEC	Peter Vamplew
Company	Cognetic Creations	Paul Wilson
Company	Zenocan	Ian Stuart
Company	Auvation	Bill Melvin
Company	Yaba	Scott Johnston
Company	Spectra	Craig Campbell

Company	(Spectra)	Janice Hunter
Company	Spektra Systems	Gordon Stuart
Company	Safedip	Ian Parsons
Company	Edinburgh Bioparks	Ian Leslie
Company	Kelvin Nanotechnology	Simon Hicks
Company	Bioadventures	Shane Booth
Company	Axeon Ltd	Hamish Grant
Company	AURIS Ltd	Liz Rattray
Company	Voxar	Andrew Bissell
Individual	Whitelaw Wells	John Ritchie

2001: n=16 (33% of survey respondents in 2001)

CATEGORY	COMPANY	CONTACT
Sponsor	Ernst and Young	Janine Renton
Sponsor	Ayrshire New Venture Centre	Christine Fox
Sponsor	Dumbartonshire Enterprise	Scott Skinner
Sponsor	Murgitroyd and Company	James Brown
Sponsor	Royal Bank of Scotland	Donald Rankin
Sponsor	Bird Semple	Chris Nicol
University	University of Paisley	Caroline MacDonald
University	Glasgow Caledonian	Frank Bell Glasgow
Sponsor	Forth Valley Enterprise	Bill Cook
University	Queen Margaret College	Kenneth Purves
Company	Kelvin Nanotechnology	Simon Hicks
Company	AURIS Ltd	Liz Rattray
Company	Bioadventures	Shane Booth
Company	Axeon Ltd	Hamish Grant
Company	Voxar	Andrew Bissell Rob MacKean
Individual	Tanya Siann	Paul Wilson

APPENDIX F:

CONNECT 'INVESTMENT CONFERENCE' SURVEY RESULTS

(35/88; response rate of 40%)

#	Year	<i>Did you directly or indirectly gain investment through your participation in the Connect Investment Conference?</i>	<i>Is there a level of investment (% of amount sought or £ amount) that you can directly attribute to your participation in the Conference?</i>
1	1998	"No investment; I don't think we were ready for external investment at that time, and did not pursue any of the leads generated".	No
2	1998	"Yes; we indirectly raised £850,00 which was split 50:50 debt and grant which was 85% of amount asked for at conference"	"We did not gain any as a result of involvement with the Conference".
3	1998	"We did not capture funding from the presentation".	
4	1998	"We indirectly gained investment from the conference and gained other intangible benefits. We did not raise money as a direct result of conference.	"Yes; over approximately £365,000 of funds raised between 1999 and 2000 could be attributed to the conference participation".
5	1998	"Probably. We were not fund raising at the time of the Investment Conference, but we knew that we would by shortly (9 months later). Our CEO presented at the conference and we showed a demo of our products in a syndicate room that was attended by a number of potential investors. Out of these I would probably cite the subsequent investment by the [certain fund] as being assisted by the investment conference".	"The [fund] investment accounted for approximately 10% of the investment amount we were seeking at that time".
6	1998	Yes. One of the critical elements of the investment conference for us was to start the ball rolling and to build on momentum from there. The VC community does tend to act locally and it was critical for us to keep [VC firm] and Scottish Enterprise on side. The other two VC funds at the investment conference who invested in us really came on the back of the original two investments and their follow-through	1.5 million
76	1999	No. "I do believe that the forum is a useful concept for young Scottish companies".	No
8	1999	"To an extend we did benefit directly, and certainly indirectly. However, we presented at several other investment conferences and to private individuals...and our funding was probably as a result of more than one specific presentation".	"Perhaps one-quarter of our early funding arose from Connect".
9	1999	"At the time of the conference, initial investment was well underway; however our main 2 nd round investor was present and expressed interest in being involved, which he did a year later".	"50% of original amount sought".
10	1999	"Indirectly. We got £100,000 from a [certain] fund [based on one person talking after their presentation] saying that he was interested in putting in this sum, negotiations followed quickly after; [investment] people were in the audience	"Investment of £1.5 million later from people in the audience".
11	1999	"We derived great benefits from the Connect conference, most indirectly, as we subsequently secured investment, but not via any of the Connect companies. However, the process was an invaluable pre-cursor to first-round funding we finally secured".	

12	1999	"No. We enjoyed and learned from the experience of presenting at the conference. The value of the networking opportunities and the lifting of our profile are incalculable".	
13	2000	"No. Our business concept was a start-up business, perhaps not ideally suited to the conference audience. The only benefit apart from the exposure to potential investors was it did focus our attention more on the planning of the business".	
14	2000	"No. We are currently in the process of fund-raising. None of the VCs we are currently in discussions with came directly or indirectly via the Connect Conference. However, it was a very good conference to help raise our profile".	
15	2000	"No. We have received in excess of £1 million of funding since the Connect conference, but none of it was as a direct result. The indirect amount is more difficult as the public relations (PR) cannot be quantified.	
16	2000	Yes. I have no criticism of the conference and believe that I failed to raise the £1 million due to core investor jitters and by being over valued (pre-sales)".	"Yes. I pitched for £1 million based on a company valuation of £4 million and only raised £100,000 and couldn't find a lead investor".
17	2000	"No direct investment came out of the presentation. It was a little too early to be asking for £1 million as the company was still quite embryonic. We did learn the sort of things needed to move the company forward though and today we are much more substantial.	
18	2000	"No, we did not achieve anything from participating at the event apart from a brief flurry of PR. We have not raised any funds directly or indirectly".	
19	2000	"We have not as yet gained any investment into our company despite considerable effort by both ourselves and our corporate advisors. We undoubtedly did make some excellent contacts at the conference and it provided a platform for follow-up that we have done rigorously. We could have achieved the same lack of success without the cost and time required to participate in the conference though. We are still actively talking to 3 potential investors where the lead organisation was not at the conference.	No
20	2000	"Presentation at the Conference was a key element in raising finance (and profile) of the company. Though the deal is yet to be closed, the conference was instrumental in making connections with 2 syndicate members. [Our company] was late in participating in the conference; hence the instrumental role played by the event is even more appreciated".	"If concluded (imminent) then 100% of financing sought will be raised".
21	2000	"Indirectly gained benefits by helping close and gaining more control over a deal that we already had in place".	"Connect didn't help contribute to the amount, but it helped in many other small ways, including understanding the investment raising process and allowing [our company] to understand that it was in a strong position for negotiation".
22	2001	We did not raise any investment from the conference. Our belief was that it was not the right type of forum for a company such as us, which has been established for 10 years, but has remained small and is now looking for a small amount of mezzanine funding. The attraction of Connect was the limited time we had	

		to put into the fund raising to gain access to a group of investors	
23	2001	No, I am afraid we did not have any investment leads after the conference.	
24	2001	Unfortunately we have not received investment through Connect or elsewhere.	
25	2001	We received no interest or investment as a result of the conference.	
26	2001	Answer to both questions sadly for us was no – hence its demise.	
27	2001	We did get benefits in terms of exposure to the VC community and assistance in refining our sales pitch. But we didn't get investment from the conference.	
28	2001	No, we had closed a funding round the week before and were primarily using the investment conference to generate profile for the company. However, we previously presented at Springboard which directly resulted in us receiving two funding offers, so the system definitely works.	
29	2001	We have not received any investment so far, but can let you know whether any contacts made at the investment conference are attributable.	
30	2001	While the conference helped to raise the profile of the company within the financial community, it didn't help with our fund-raising efforts.	
31	2001	Our company derived great benefit from the Connect process, mostly indirectly, as we subsequently secured investment. The process was an invaluable pre-cursor to the first-round funding we finally secured.	
32	2001	We haven't yet closed any additional funds.	
33	2001	We had initiated discussions with [VC firm] but had not met them at the time of the 1999 event. The event itself was the first time we got together and we did receive funding	I cannot attribute a specific amount exclusively to the Connect event but we raised 2.5 million from two VC firms.
34	2001	The presentation at the investment conference was instrumental in us attracting equity investment – no question. As well, the process of applying as a candidate presenting company is of benefit. It enables a critical assessment of the application so enabling the company to get its case together. This I have found to be of immense value	We have attracted 80% of the equity investment solicited and hope to plug the gap by grant assistance.
35	2001	We did not directly or indirectly obtain investment through the investment conference. Investment came much later when our company merged with [another company] to become [a third company]. Overall Connect has been a very useful organisation for us, as the events are informative and provide a good networking opportunity.	

APPENDIX G:

CASE STUDY PRE-INTERVIEW LETTER

Mr. Scott Johnstone
Marketing Director
Yaba Ltd

Dear Mr. Johnstone,

I very much appreciate your willingness to participate as a case study company in evaluating. As a first step, I would like to request any readily available information you can provide so that we can gain more familiarity with your company, including:

1. How the company came into being.
2. History and evolution of company
 - ◆ Milestones and challenges in technology and company development
3. Organisational structure
4. Critical success factors as they relate to the following areas:
 - ◆ Technology
 - ◆ Market
 - ◆ Management
 - ◆ Finance
5. Effects of support programs in addition to Connect

I would like to interview you at your earliest possible convenience and will travel to meet you at your preferred location. You may wish to give some thought to other people I can talk with that can provide further information on the above areas. I suspect that much of the information will come from yourself, particularly in reference to your ongoing relationship with the Connect program and its effects on your company.

Thanks again for your participation and I look forward to working with you on this project.

Sincerely

Geoff Gregson

APPENDIX H:

SEMI-STRUCTURED INTERVIEW FORMAT FOR POST SPIN-OUT ASSESSEMENT TO CONNECT DIRECTORS (MAY 2002)

1. You've been a spin-out company now for almost one year.
 - What do you feel are the key **milestones** for Connect over this last year?
 - What have been the key **challenges**?
 - What has been the key **changes** to Connect's business model since June 2001 and why?
2. Could you discuss the **membership package** for new companies?
 - Why, what are your targets and how many companies are signed up to date?
3. You have identified **5 key 'network effectiveness' aims**. How will this effectiveness be established or measured?
 - Are the objectives of **recurrent events** still the same?
 - The relationship with **universities**: what processes are involved in developing Connect as an effective outreach mechanism for spin-out and collaborative project development? How is Connect working with the universities?
 - What are the strategies to ensure return on investment for sponsors? What are the expectations of public sponsors?
 - How does connectonthenet.com fit in?
4. What **changes in Scotland** are affecting Connect as a private-sector driven enterprise support network?
5. What are the **issues of 'managing'** a formal regional enterprise support network; i.e. having three regions, what are the differences between the regions and the effect on program delivery and support?
6. What **lessons** would you suggest are applicable for other enterprise support networks in general (applicability to other regional programs)?
7. How would you describe the STRENOf **network ties** between those seeking resources and those providing resources in the network, i.e. sponsors (public vs private) and member companies?
8. How would you describe Connect's **SWOT** strengths, weaknesses, opportunities and threats at present?
9. What are the **key reasons** for tech entrepreneurs coming to Connect-has this changed in the last 5 years?
10. Is a **flow-through** of tech companies occurring, i.e. moving on from Connect, and what other networks pick up where Connect leaves off, i.e entrepreneurial exchange?

APPENDIX I:

COMPLEMENTARY SUPPORT MECHANISMS: Public SEED Funding Schemes

Type of Scheme: Public
Name: PROOF OF CONCEPT FUND
Region: Scotland
Years in existence: 4 years (since 1999)
Contact information: Web-site: www.scottish-enterprise.com/proofofconceptfund/ Contact person: Eleanor Taylor Tel: 0141 228 2246
Stated objectives: To allow academic innovative thinking at a pre-development, conceptual stage to be developed for the marketplace and used as a basis for growing new companies.
Expected outcomes: No private funding is required but the output of the research is expected to attract significant private investment and lead to commercial (not further research) activity.
Eligibility criteria: Available to universities, research institutes and National Health Service (NHS) Trusts in Scotland. Candidates will be assessed using the following criteria: <ul style="list-style-type: none"> • Economic impact on Scotland • Existing IPR • Competitive advantage through innovation • Commercial exploitation • Collaboration with other emerging technologies and clusters • Project cost and duration • Other funding
Funding partners: Scottish Enterprise (Scottish Executive)
Results to date: Rounds 1, 2 and 3 (closing October 2001) From Round 1 eight Science and technology projects were accepted for PoC funding from 83 applications, which totalled over £20 million worth of bids. Round 2 had 126 proposals, 36 projects were awarded. Up to £5 million is available for funding projects in round 3 including up to £600,000 for other emerging technologies.
Total projects: 50 plus projects (out of 209 applications)
Funds provided: Total fund is £29 million
Average funds per project: Up to 100% grant of between £50,000 - £200,000 (ex overheads) is available for 2 years.

Issues with scheme: Finite, with third and final round being competing in 2001.
<p>Showcase project: Rowett Institute was awarded £360,000 proof of concept funding from Scottish Enterprise in April 2001. The Rowett Research Institute based in Aberdeen was awarded a total of over £360,000 from the Scottish Enterprise Proof of Concept Fund for three projects. The ideas for the Rowett projects have been generated from the fundamental research carried out at the Institute, and the funding will enable further essential research to be undertaken before the commercial potential of the product can be investigated.</p> <p>Says Professor Peter Morgan, Director of the Rowett Research Institute. "The Proof of Concept funding clearly fills a gap in the process of exploiting research outputs. Gaining funding for three projects is a clear marker of the quality and relevance of the Rowett's research programme".</p> <p>Contact Sue Bird, PR Manager, Rowett Research Institute, Tel: 01224 716668, mobile: 07711 093417</p>
<p>Assessment of effectiveness of scheme:</p> <p>According to Eleanor Taylor, Manager of the Proof of Concept Fund, companies throughout Scotland are now being founding solely on the work of research scientists. She states that the fund offers maximum flexibility to applicants and tries to complete the decision-making process within 10 weeks.</p> <p>The fund can be accessed through the internet.</p>

Type of Scheme: Mixed (public-private)
Name: EDINBURGH TECHNOLOGY FUND (UNIVERSITY CHALLENGE FUND)
Region: Edinburgh research institutions
Years in existence: 4 (since 1999)
<p>Contact information: Roslin Biocentre, Roslin, UK, EH25 9PS</p> <p>website: http://www.ed-tech-fund.ed.ac.uk</p> <p>Contact person: Dr Keith Winton</p> <p>e-mail: etf@ed.ac.uk</p> <p>Tel: 0131-527 4545 Fax: 0131-527 4546</p>
<p>Stated objectives: ETF targets the world-class research community in and around Edinburgh, seeking to invest money in emerging technologies, and research entrepreneurs, that demonstrate the potential to establish new commercial opportunities capable of generating significant income to be returned to the community. ETF seeks to help Research groups build on their own internal strengths through innovative approaches to leveraging resources for competitive advantage. To address the very early stage funding gap that is a barrier to transfer of emerging technologies from the UK Research base into commercialisation.</p>
<p>Expected outcomes:</p> <ol style="list-style-type: none"> 1. To create clusters of new company start-ups 2. Improving licensing portfolios at each of the members of the consortium
Eligibility criteria:

- Applicants must be members of staff of, or students registered with, one of the member institutions of the ETF Consortium.
- Exceptionally, applicants may be companies previously set up to exploit the technology of a Consortium member, provided that the institution still has a substantial share holding in the company. Projects must have the objective of elucidating both the technical development and the commercialisation options. Members of staff of any ETF Consortium member
- Students registered with any member Companies controlled by a Consortium member.

Funds will be made available as unsecured loans or reimbursable grants. At the discretion of ETF, these loans (or grants) may be converted into equity in the event of a company being established to exploit the relevant technology. Alternatively, the loans will be repayable in the event that the recipient secures commercialisation of the technology. Payment regimes will be based on revenue to the recipient of the loan and will be calculated on the amount of the loan and the repayment period. Normally, the total repayment will be limited to twice the amount of the monies advanced by ETF.

Funding partners:

- University of Edinburgh
- Moredun Research Foundation
- Roslin Research Institute
- UK Astronomy Technology Centre
- Edinburgh Station of the British Geological Society
- Office of Science and Technology; European Commission, ERDF Programme
- Lothian and Edinburgh Enterprise Ltd
- City of Edinburgh Council-Midlothian Council
- Edinburgh Technology Transfer Centre

Average funds per project: £200,000

Issues with scheme: All intellectual property created or developed during the course of a project supported by ETF will become the property of the Institution or Company promoting the project. The ownership of all background intellectual property brought to the project will be unaffected by the ETF investment. As a minimum requirement, there will be an obligation on the Institution or Company receiving an investment to grant a licence, with the right to sub-licence, to any background and project results, to any third party through which commercialisation of technologies supported by the investment is ultimately effected.

Funding may be used to develop prototypes, proof of technical feasibility and/or perform market research. Funds may not be applied to the purchase of equipment or solely for the purpose of conducting marketing feasibility studies or preparing marketing plans. Developing sales or marketing efforts will not be considered eligible since this would imply that the technology has been well-enough defined to already be marketable.

In general for ETF Investments, applicants are required to demonstrate their commitment to the commercialisation of technologies either through providing inputs from their own resources or through leveraging contributions from other sources. Matching funds may either be cash or in-kind contributions on which a monetary value can be placed. For Technology and Business Assessment Investments, no matching contributions are required for the first £10,000 of costs. Applicants must meet all costs over and above that figure.

INDEX – PUBLISHED PAPERS

This addendum contains copies of the following peer-reviewed, published papers from this thesis, in accordance with the University of Edinburgh's *Postgraduate Study Programme* regulation 3.9.11 Regulatory Standards for Format and Binding, 2001/02, page K-30.

1. Collinson, S. and Gregson, G. (2003) "Knowledge Networks for New Technology-based Firms: An International Comparison of Local Entrepreneurship Promotion". *R&D Management*, 33 (2), 189-208. ISSN: 0033-6807.
2. Molina, A. and Gregson, G. (2002) "Real-time Evaluation Methodology as a Learning Instrument in High Technology SME Support Networks". *International Journal of Entrepreneurship and Innovation Management*, 2 (1), 69-99. ISSN 1368-275X.
3. Gregson, G. (2002) "Building a National Network of Support for Academic Spin-outs and Technology-Based Companies in Scotland" in P. van der Sijdie, A. Ridder, J. Gomez Gras, D. Galiana Lopera and I. Mira Solves (eds.) *Infrastructures for Academic Spin-out Companies*, Alicante, Spain, UMH Press, 365-400. ISBN 84-931726-2-6.
4. "Building a National Network of Private-Public Support for High Technology Start-ups in Scotland", *In Proceedings of the British Academy of Management 2002 Conference*, September 2002, London, England, Paper bam438.

Knowledge networks for new technology-based firms: an international comparison of local entrepreneurship promotion

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This paper reports on an international comparison of three organisations established to promote new business start-ups in the USA, UK and Canada. A 'knowledge-based' approach is adopted to examine how networks of would-be entrepreneurs, interact with networks of experienced entrepreneurs and managers, venture capitalists, technical experts, consultants, IPR lawyers and other specialists. This interaction is promoted and mediated at the local level by the three organisations at the centre of the study: the Austin Technology Incubator (ATI), Texas; Connect, Edinburgh; and the Canadian Environmental Technology Advancement Corporation (CETAC-West) in Canada. These act as local network-nodes or 'knowledge integrators', as well as 'incubating' new ventures to increase the new business 'birth rate' in their respective regions.

The comparison is based on interviews and secondary data that describe the initiation, development, operation and local impact of these organisations. Findings stress the importance of the regional context as a source of particular kinds of knowledge and expertise that may promote or inhibit new technology-based business start-ups. In particular: the scale, scope and quality of ideas and business proposals in local networks; the availability of relevant expertise and experience for 'intelligent selection' and for successful mentoring; the nature of rewards and incentives for all players; and the importance of local champions or figureheads, are all factors that help explain differences across the example regions.

The paper combines a variety of conceptual approaches around the idea of regional knowledge networks which underpin 'distributed innovation'. Heightened technological and market uncertainty for new technology-based firms places a premium on the ability of entrepreneurs to integrate specialist knowledge and utilise expertise from a variety of local sources. Despite differences in the scale, scope and effectiveness of their efforts we conclude that all three organisations are supporting 'accelerated learning' amongst entrepreneurs.

Simon Collinson and Geoff Gregson

Introduction

This paper provides an international comparison of local entrepreneurship promotion in three countries, Canada, the UK and the USA. The Canadian Environmental Technology Advancement Corporation (CETAC), Connect Scotland and the Austin Technology Incubator in Texas are three public-private organisations all focused on the promotion of entrepreneurship and new business start-ups in their respective regions.

A 'knowledge-based' approach is adopted to examine how networks of would-be entrepreneurs, interact with networks of experienced entrepreneurs and managers, venture capitalists, technical experts, consultants, IPR lawyers and other specialists. This interaction is promoted and mediated at the local level by the three organisations at the centre of the study. The focus of this paper is to examine and compare the initiation, development, operational mechanisms and resulting 'impact' of these organisations. What mechanisms, activities and events have they used to enhance regional 'connectivity' and how have the different regional contexts influenced their ability to support new technology-based ventures?

CETAC offers a combination of management, marketing, and technical support directed towards helping new ventures attract financing and successfully launch their products into domestic and international markets. Connect, similar to the Canadian business development model, has focused resources through a specific strategy at improving the birth rate and early development of new enterprises. Connect is also focused on attempting to improve what is generally regarded as a low entrepreneurial culture in Scotland compared to the USA and Canada (Scottish Enterprise, 1993, 1996).

CETAC is more interventionist than Connect, in that it actively seeks financing for selected technology-based firms and engages in management mentoring. Connect currently limits itself to 'improving connectivity', bringing entrepreneurs, venture capitalists and other specialists and professionals together to generate the synergies needed for new business development. The ATI is the most interventionist of the three in that it not only encourages the required networking but it selects new ventures and 'incubates' the most

promising, providing infrastructure and in-house support to improve the chances of success.

Just as the related studies described below come from a range of literatures, this paper contributes to a number of related fields of enquiry. Clearly there is a regional economic development dimension and a related policy aspect of the study centred on the justification for, and effectiveness of, supportive mechanisms for entrepreneurship and enterprise creation. The extensive literature on 'agglomeration economies' and more recent studies of high-technology 'clusters' and regional 'innovative milieu' provide the relevant context at this 'regional networks' level.

There is also a management dimension and a promising confluence of different approaches is currently taking place which this paper aims to contribute towards. The distinctive literatures on entrepreneurship, R&D and technology management and innovation studies are, in combination, providing better insights into an understanding of the genesis and evolution of new technology-based ventures. Added to this is the emerging field of 'knowledge management' studies and, in particular, analyses that have looked at intra-firm and inter-firm mechanisms for knowledge-sharing and 'knowledge-integration'. These newer approaches provide insights into the kinds of entrepreneurial and innovation networks that are of interest here.

This study

The comparison described here is based on case studies of the above organisations, compiled by the authors through a combination of questionnaires, site visits, structured interviews and secondary data. The most comprehensive study has been made of Connect, commissioned and funded by the Scottish Higher Education Funding Council (SHEFC) partly to measure the regional impact of the organisation on behalf of stakeholders and regional policymakers. The Connect study has involved all of the above methods of data collection with members of Connect, stakeholder organisations, professional service firms, venture capital firms and associated new ventures all included in the empirical study. In addition to assessing the growth and development of Connect as an organisation, a total of

113 members of Connect were interviewed and surveyed to determine the perceived value derived from the Connect programme, and case studies were completed on six technology companies.

The CETAC-West study also involved structured interviews in Canada and benefits from the insights gained by one of the authors of this paper (Geoff Gregson) who worked in the organisation in 1998. Further information for CETAC has come from the co-author's MSc dissertation assessing CETAC (Gregson, 1999) and a number of CETAC working documents (see bibliography).

The study of the ATI in Austin is the least comprehensive of the three, compiled through site visits, unstructured interviews and a number of secondary studies. It does benefit from the reports and academic papers produced by key members of the ATI and IC² organisations on the 'Austin high-tech growth phenomenon' and on the part played by these network facilitators in promoting new businesses (see below).

The paper's international comparison comes with a qualification on generalising results. It is acknowledged that programmes and policies start out with different objectives and will achieve different results based on the characteristics of each region. Networks operate very differently according to the specific economic, social, political and cultural contexts that make up different regions (Curran and Blackburn, 1994; Morgan, 1997).

Regional knowledge networks

This paper attempts to combine a variety of conceptual approaches around the idea of regional knowledge networks.

Innovation studies

The innovation process at the heart of new start-ups is seen as a collective, evolving endeavour, taking place across interconnected networks, in contrast with the more usual idea of a single owner-manager with a 'ready-to-sell' business idea. Multimedia and online products and services generated by the convergence of IT, telecoms and consumer electronics provide the obvious examples in which rapid technological change, coupled with newly-emerging markets

increase the level of uncertainty for new technology-based firms (Oakey *et al.*, 1999).

Taking an evolutionary economics perspective Metcalfe in Archibugi and Michie (1997) links the need for market intervention to support innovative capacity with 'information asymmetries' which are heightened in times of rapid change. These also emphasise the importance of networks for information, knowledge and expertise to maintain adaptability and survival.

For start-ups attempting to commercialise new internet or e-commerce related products or services, for example, a complex and continually changing array of both technological opportunities and threats and market opportunities and threats places a premium on 'integrative mechanisms' for combining relevant knowledge from various 'knowledge networks' to steer the research, development and commercialisation process (Collinson, 2000). Innovation is where technological and market opportunities coincide and in these kinds of highly dynamic environments it is more usefully viewed as an interactive learning process. The 'interactive' or 'coupling' model of innovation, as opposed to the 'linear model', has been shown to be more appropriate in such contexts (Asheim and Cooke in Malecki and Oinas, 1999).

Recent research, extending the field of innovation studies, has focused on 'distributed innovation', where contributing organisations coordinate their efforts to create new products, processes and often (as in the context discussed here) new enterprises. A core research theme at the Centre for Research on Innovation and Competition (CRIC) at the University of Manchester, is to examine the 'collective action amongst firms in a distributed innovation network which cannot be reduced to market transactions and formal contracts'. CRIC suggests that priority should be given to research in three areas (Coombs, 2001; Metcalfe, 2000), all of which are addressed in this paper:

1. The coordination mechanisms that facilitate innovation networks;
2. The risks and incentives for network participants;
3. The competitive advantages, demonstrated by the additional returns to members, which result from 'superior' networks and/or highly efficient coordination mechanisms.

Knowledge-based approaches

The above emphasis on 'integrative mechanisms' parallels the concept of 'integrative capabilities' in the context of individual firms, reflecting the varied efficiency and effectiveness with which large corporations manage the intra-firm exchange, development and application of specialist knowledge for innovation (Collinson, 2001, 1999, 1997; Iansiti, 1995; Leonard-Barton, 1995; Teece, 1998).

High levels of uncertainty for new technology-based firms again place a premium on networks as a means through which entrepreneurs can update knowledge and test the validity of their own ideas about commercialisable technologies and products and necessary alignments and partnerships with 'experienced experts' (Bruderl and Preisendorfer, 1998).

Entrepreneurial network theory that suggests that strength, complexity and diversity of business relationships influence newly formed enterprise performance, resulting in improvement of the longer term chances of firm survival and growth (Shahidi, 1998; Tremblay, 1998). Monsted (1993) distinguishes between three types of networks, with each serving a different function for the entrepreneur: networks for service and assistance; networks for information and structuring, particularly for knowledge about whom to contact for a specific purpose; and networks for entrepreneurship and product development. In addition to a supply of resources, networks provide social support and self-confidence and strategic capacity to learn and organise for new activities (Johannisson, 1995). Effective network participation, however, requires communication skills, trust, co-operativeness and other capabilities in the entrepreneur (Pihkala *et al.*, 1999).

Again the importance of informal social interaction as a starting point to knowledge acquisition for the entrepreneur is stressed. Initial contacts from social networks evolve into business-focused networks, and then into strategic networks, which allow firms to innovate and to thrive by their links to other organisations (Aldrich and Zimmer, 1986; Butler and Hansen, 1991; Dubini and Aldrich, 1991; Falemo, 1989; Flynn, 1993; Johannisson, 2000). Experienced entrepreneurs share a variety of business knowledge that is essential in operating a business, from sources of finance to internal HRM management.

During the start-up phase entrepreneurs particularly need to mobilise 'social resources' because of liabilities that include size, lack of market legitimacy and newness (Sharman *et al.*, 1991; Starr and MacMillan, 1991). Small enterprises are also more likely to rely on entrepreneurs who have the development of the local community and its firms as a goal (Cromie, *et al.*, 1993; Johannisson and Nilsson, 1989; Johannisson, 1990). These provide reasons for the effectiveness of good mentoring for start-ups, shown by Deakins *et al.* (1998).

Small, start-up firms are arguably constrained far more by knowledge limitations than by financial limitations. Networks may or not act as the source of several kinds of critical knowledge or expertise, particularly (as found in Collinson, 2000):

- strategic: helping them match technological and market opportunities
- managerial: supporting the human-resourcing, organisation and financing of the new enterprise
- technical: assisting with design and development or core products and relevant technical alliances

Clearly the issue of 'strategic choice' is central for entrepreneurs and the first theme above has been a strong focus in the strategy literature for some time. Knowledge assimilation to inform decisions regarding finite resource-allocation, from the selection of target markets to investment in emerging technologies, is a strong determinant of success (Child, 1972).

Various knowledge-based approaches focus on different characteristics of knowledge in different organisational contexts. A central theme is the differentiation between tacit and explicit or codified knowledge, initiated by Polanyi (1966), which has given us insights into the relative ease or difficulty of transferring different kinds of knowledge within or across different kinds of organisational contexts. Context-specificity and organisational 'embeddedness' are also important and relate to the 'distinctiveness' of particular firms, or inter-firm networks, from which they may gain a relative competitive advantage. Nonaka's concept of 'knowledge-creation' (Nonaka and Takeuchi, 1995), for example, is built around these themes. Similarly, Coombs and Hull (1997) examine knowledge accumulation mechan-

isms, interface mechanisms and deployment mechanisms in the context of innovation networks. Howells (2000) also connects innovation systems and knowledge systems effectively.

Analysis of practical managerial issues that are of direct relevance to entrepreneurs, such as how to access particular kinds of specialist knowledge to support a new enterprise, requires an understanding of more complex factors, such as the incentives for knowledge-sharing, as well as the relative ease or difficulty of knowledge transfer. The value or 'tradability' of different kinds of knowledge in different contexts (Fleck in Williams *et al.*, 1998) and the long-standing link made between knowledge and power are important factors directing flows of knowledge in networks (Hislop and Newell, 2000). The notion of 'social capital' has long been used to encompass many aspects of the socially-constructed and mediated nature of knowledge and expertise (Fincham *et al.*, 1994).

Regional knowledge networks and market intervention for local development

The differences between the three organisations in this study are also explored in the context of the theoretical and empirical work on high-technology 'clusters', 'agglomeration economies' or 'innovative milieu'.

Innovation studies have examined the distinctiveness of regional institutional infrastructures and mechanisms for interaction and coordination mainly through contrasting 'national systems of innovation' (Edquist, 1997; Freeman, 1995; Lundvall, 1992; Nelson, 1993). But another, broader and deeper research tradition which often comes under the umbrella term of 'economic geography', has been concerned with agglomeration economies and the regional implications of networks for much longer (Coe and Townsend, 1998; Cooke *et al.*, 1998; Cooke, 1996; Malecki and Oinas, 1999; Oahey *et al.*, 1999). Both have strong links with regional economic development policy literature.

The abovementioned notion that participants in effective and efficient innovation networks reap 'additional returns' from the associated competitive advantages is paralleled in the regional economic development policy literature (Huggins, 2000; Ritsila, 1999; Gibb, 1993). For a

long time regional economic development agencies all over the world have invested public money into schemes to facilitate and strengthen particular kinds of local networks in the belief that these support local competitive advantages and give rise to additional capital investment, employment and higher new business birth-rates.

The Silicon Valley region of California provided one of the first 'ideal models' with high levels of technology-based enterprises underpinning a dynamic, high-growth regional economy that other regions sought to emulate. Studies (such as Saxenian, 1994) again point to the institutional and social characteristics and the nature of technical expertise networks in the region as key factors promoting entrepreneurial flexibility and perhaps limiting the transferability of the model to other regions.

The central questions still remain within the on-going debate on the role of governments in supporting this kind of economic growth at the regional level. What *degree* of intervention in the 'invisible hand' of the market should government's support? Can and should public sector organisations be involved in 'picking winners'? What kinds of mechanisms are effective in developing the 'requisite connectivity' to stimulate new business growth?

In keeping with the knowledge-based approach advocated here this study focuses on the mechanisms used by three public-private organisations to build and support networks of specialist knowledge to promote local entrepreneurship. Figure 1 illustrates some of the main components of the regional networks examined, including a representation of the network of would-be entrepreneurs across various industries, technologies and markets, with new business propositions. The overall 'pipeline' represents the 'natural selection' process or 'decay rate' as eventual success-stories evolve from business plans to full corporations and failed enterprises exit. The stages depict the main kinds of intervention practiced by the three organisations in this study.

Stage 1. All three organisations are involved in activities that stimulate the overall degree of interaction and networking amongst entrepreneurs, financiers and venture capitalists, intellectual property rights (IPR) experts and other legal specialists, professional managers, technical specialists etc. in the local region. The aim is to

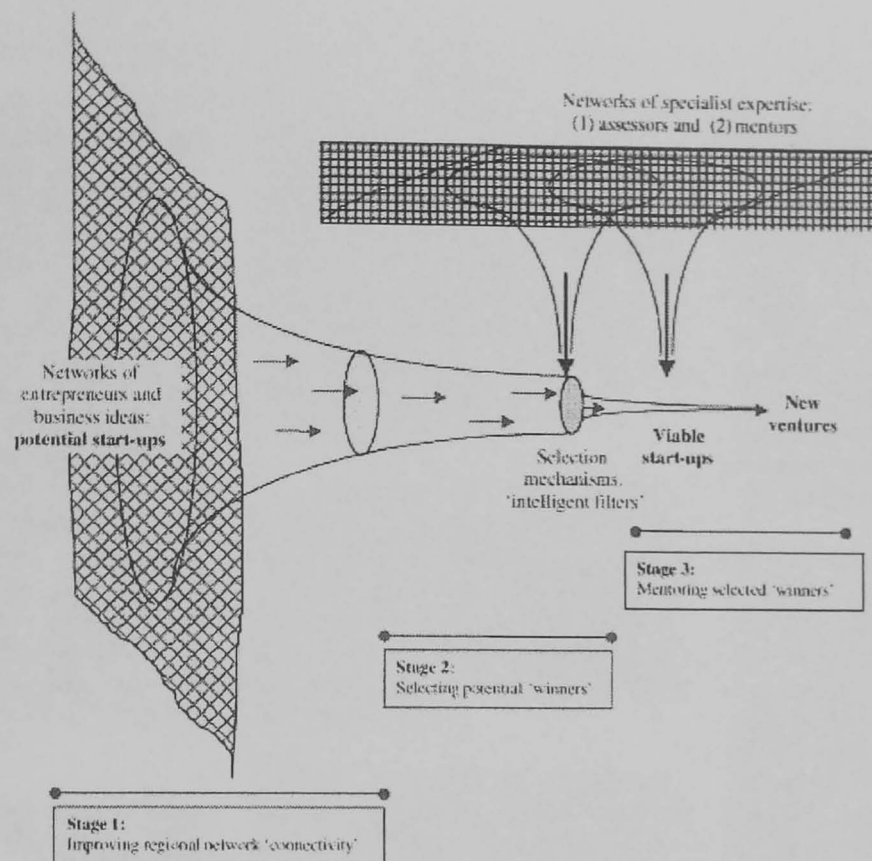


Figure 1. Knowledge networks and stages of intervention for new business formation.

maximise regional 'connectivity' to improve the level of network interactions likely to lead to the formation of new businesses. Connect is limited to Stage 1 activities only and CETAC-WEST is more focused than both the other organisations on Stages 2 and 3.

Stage 2 and 3. CETAC-West and ATI select particular business propositions for hands-on development and 'mentoring'. In this role they rely on a second local network of associated 'experts' of the kinds listed above which they coordinate and co-opt to advise on new business potential, filtering the most promising for further attention, and engage to directly assist the development of the new business.

The regional availability of certain kinds of experience and expertise, the breadth, depth and 'quality' of this second network, combined with the effectiveness of the mechanisms used to coordinate and co-opt its members for both 'informed' selection and value-added mentoring jointly determine the success of the overall process. The various activities involved in each of these stages can be more or less easily

measured in terms of their effectiveness and local impact and we will return to this issue below in our comparison.

Entrepreneurship-support organisations: an international comparison

Each of the three organisations, CETAC, Connect and ATI, will be examined according to their origins, mandate and objectives (section 2.2), operational mechanisms (2.3) and results (2.4). Section 2.5 provides an analysis of the impact of each program and provides insights into how these organisations are effective as knowledge network promoters.

Origins, mandates and objectives

Table 1 compares the origins of each of the three regional network organisations studied, Table 2 their central missions and objectives and Table 3 their organisational networks and partnerships.

Table 1. Origins.

Connect	CETAC	ATI
<p>The rationale for Connect is based on research evidence (Scottish Enterprise, 1993, 1996) that the development of high growth and high technology enterprises requires interaction between the university sector, large corporations, emerging companies, regional government and support groups. Connect was developed against a background of the Technology Ventures Strategy. Technology Ventures broad aim is to establish new businesses and jobs within Scotland and is based at Scottish Enterprise. Technology Ventures itself was created as a result of a Commercialisation Enquiry conducted jointly by the Scottish Office and the Royal Society of Edinburgh.</p> <p>Connect was located at the Management School following strong support from the University of Edinburgh and its Principal for the notion of Connect. The original champion of Connect is Ian McDonald. Since January 1996, he has been solely responsible for championing a Scottish version of the original San Diego Connect project. He personally enrolled the support of a number of founding sponsors largely drawn from the private sector.</p>	<p>The primary rationale of CETAC is to assist start-up new ventures in building better businesses around their environmental technologies. Projects are typically at the early stages of commercialisation, namely concept or development. The focus is on bridging the distance between research and development and successful market launch.</p> <p>A second rationale for CETAC-West is its role as champion in the environmental technology sector. CETAC-West has identified the need for the environmental sector to acquire stronger managers and has developed initiatives to address that need.</p> <p>CETAC is a federal government-initiated support program seeking global solutions developed in the Canadian context that reduce commercial cycle time, thus reducing overall project costs and lowering investment risk. There is encouragement of strong industry participation to increase the rate of growth of the environmental technology industry and generating wealth within Canada. CETAC (west) is responsible for the four western provinces; Manitoba, Saskatchewan, Alberta and British Columbia.</p>	<p>The Austin Technology Incubator (ATI) was launched in 1989 at the University of Texas at Austin, through its IC² ('Innovation, Creativity, Capital') Institute. Initial funding was from The University of Texas at Austin, the Greater Austin Chamber of Commerce, the City of Austin, Travis County, and local businesses with a remit to promote the growth of new science and technology-based enterprises.</p> <p>The ATI was co-founded by University academic Dr George Kozmetsky, who was associated with the founding of the Dell Corporation (now with revenues of \$25 billion) by an Austin student, Michael Dell in 1984. He was a founding Director of IC² and a central 'node' in the academic, business and public sector (primarily the Greater Austin Chamber of Commerce and the City of Austin) networks that promote start-ups in the Austin region.</p> <p>As an incubator ATI provides facilities, finance and guidance to fledgling firms in return for an equity stake. It began with 4,000 sq. ft. in 1989 and now occupies 50,000. Proposals for new ventures are 'filtered' by a panel of experts. Those that are accepted are located within the incubator for 'nurturing'.</p>

Figures 2–4 then map out these networks graphically.

Operational mechanisms

Connect. Table 4 shows the activities and events that include briefings, lectures, courses, workshops, conferences, technical and social support. The six Connect events shown in Table 4 are expected to play a role for specific target audiences and they all combine to fulfil the targets of the overall programme.

There are three recurring types of events that are considered core activities for Connect, in that they are intended to involve the greatest number

of participants and maintain a continuous flow of learning among stakeholders: These events are *enterprise workshops*, *an audience with ...*, and *technology briefings* – the first two focused on enhancing general managerial skills and stimulating learning from the experience of others, whereas *technology briefings* provide a forum for actual business processes of collaboration to be initiated.

Table 4 shows three additional types of events: two annual conferences (Investment and Partnership) and the Springboard Workshop delivered on a flexible but less than frequent basis.¹

An important aspect of recruiting new company members is scanning a variety of sources for

Table 2. Mission and objectives.

Connect	CETAC	ATI
<p>The notion of constituency is synonymous with CONNECT, as its core competency appears to be networking individuals and organisations. The original aim was to provide '...an infrastructure which academics can use to better understand the needs of industrial and financial sectors, and to commercialise their research' (Proposal to the Principals/Directors of Higher Education Institutions funded by the Scottish Higher Education Funding Council, 21 July 1997). <i>To support the creation, development and growth of technology-based enterprise throughout Scotland.</i></p> <ol style="list-style-type: none"> 1. Develop and educate an expert infrastructure that understands and supports the needs of technology-based venture; 2. Facilitate and support the transfer of technology from the Scottish science base to new and existing firms, either by spin-out or through collaborative projects; 3. Enhance the ability of new and existing firms to secure finance; 4. Educate entrepreneurs about business development and issues germane to their industries; 5. Help entrepreneurs to define new businesses and whether they should start them. 	<p>An important philosophy of CETAC-West is that <i>'the corporation makes winners, it does not pick winners'</i>. It is expected that the market, and investors, not CETAC-West, should pick the winners. One of the key features of the CETAC-West process is that projects are analyzed from the investor's perspective.</p> <p><i>CETAC-West will guide small and medium sized technology-based environmental enterprises through a market driven commercialisation process to domestic and international markets.</i></p> <ol style="list-style-type: none"> 1. Add the best value to technology development projects by using experienced mentoring and procuring the best available expertise; 2. Bring experienced management and private capital to the environmental technology sector in all western Canadian provinces; 3. Follow through, thus making our clients successful and generating revenue for CETAC-West by enabling our clients to pay fees out of finances attracted to their projects. 	<p>The ATI's mission is to <i>'provide business resources and professional services that assist its technology startups to compete in the global marketplace'</i>.</p> <p>Alongside this it also has a regional development remit linked to the policy mandates of local business organisations to <i>'develop an infrastructure for regional economic development while building technology-based firms to provide high-tech and value added jobs in the city of Austin and Travis County.'</i></p> <ol style="list-style-type: none"> 1. Maintain a rigorous selection process to pick the most promising new technology-based ventures from proposals. 2. 'Accelerate learning' by providing selected ventures with access to the most appropriate mentoring support, financial resources, managerial, technical and other specialist expertise. 3. Leverage economies of scale across all resident firms in dealings with suppliers and service providers. 4. Promote regional economic benefits by maximising rate of successful start-ups.

companies that Connect staff views as relevant for membership. The Connect database of contact firms is thus constantly expanding.

Figure 5 illustrates the range the delivery and communication interface and feedback processes used by Connect.

CETAC. CETAC has adopted a 'mentoring' approach to working with clients, and delivers services designed to make new ventures financeable. CETAC has created a commercialisation process that includes a 5-step project assessment model designed to move each new venture through sequential phases (Table 5). The goal is to assist the entrepreneur in developing the venture to a point where the project is considered financeable, and then to expose the new venture to potential investors, who will choose those ventures considered worthy of investment.

Thus, unlike Connect, where the network is broad and composed of large numbers of non-specific stakeholders, CETAC creates a network specifically customised around the entrepreneur and the requirements for the project.

CETAC has segregated its activities into two broad categories: core and non-core programmes and services. The core business comprises direct services to enterprises aimed at assisting them to achieve commercialisation of environmental technologies. The key focus of core services is to build a stronger enterprise to allow the entrepreneur to be better prepared to attract financing and utilise the funds raised. Improving management capabilities is an important part of the core services.

The CETAC core commercialisation process applies to projects at all stages of commercialisation. It is an iterative process consisting of several

Table 3. Organisational networks: partners and stakeholders.

Connect	CETAC	ATI
<p>Connect has a total of 54 sponsors, that pay £3000 per year to support the programme. These include all 14 Scottish universities, nine public sector companies, five private companies, nine consulting firms, eight law firms and nine financial firms.</p> <p>Sponsors are primary shareholders; providing input and guidance regarding Connect events and activities.</p> <p>There are approximately 100 companies that are members of Connect and 35 individual members. They pay £100 per year in exchange for membership.</p> <p>There has been a five-fold increase in members of Connect between 1997 and 2000.</p>	<p>The original stakeholders are the Canadian federal government and the four western provinces.</p> <p>CETAC-West utilises various partners, from both the private and public sectors, to assist in verifying the technologies of each new venture, with the goal of attracting financing to pilot the technology. If success can be demonstrated with the pilot, further financing may be available from private investors. The pilot, therefore, stimulates other activities. These technical linkages allow CETAC to concentrate on moving the project forward while technology is verified with other agencies.</p> <p>The private sector plays a key role in mentoring clients to develop managerial skills and project strategy. CETAC has developed a team of business leaders that are brought in to form a 'round-table' or forum, to discuss project strategy with each client, following the evaluation of the project by a CETAC-West analyst. The advice can range from discussion of financial issues to marketing strategy, and the round table attendees are selected from a pool of CETAC advisors according to their potential to add value to the client's project.</p>	<p>The ATI occupies university space in the northwest of Austin. Member company fees and grants from the City of Austin and the Greater Austin Chamber of Commerce fund it. One percent of all member companies' equity is also given to ATI.</p> <p>The ATI's 60 graduate and 19 resident companies have: created over 2000 jobs; generated cumulatively over \$900 million in revenue from 1989 to 2000, and; raised over \$300 million in capital in eleven years. Five firms from the incubator have gone public.</p> <p>Member firms and organisations of the various networks and associations constitute a broad base of partners and stakeholders. Members provide the 'intellectual capital' used to filter new venture proposals and mentor start-ups that are resident at ATI. These include: the Capital Network (TCN), 'matching entrepreneurial ventures with investment capital'; the Austin Software Council; the Texas E-Commerce Association; and the broader 'Knowledge Network'.</p> <p>IC² also has a 'Fellows' network which extends abroad and the University of Texas at Austin lies at the centre of a range of related specialist networks.</p>

steps: environmental business opportunity assessments, strategy development, making projects 'financeable' and bringing financing to projects. Through the use of this process, gaps are identified in each project's ability to meet financing criteria. Project strategy, with assistance from appropriate mentors chosen by CETAC, is developed to fill those gaps and to commercialise the project, and the client is assisted in locating investment capital. The core service process is shown in Figure 6 below.

ATI. The ATI is involved in picking, developing and hosting 'winners' as well as promoting local entrepreneurial network connectivity. It filters and selects new ventures to host in the incubator

and provides a range of support services to those it sees as having the most potential. Each year the ATI receives about 200 enquiries from potential entrants and about 75 executive summaries of full business plans. About half are selected for analysis by the experts on the 'Success Committee' made up of venture capitalists, technologists and other successful entrepreneurs (the membership is listed at: <http://www.ic2-ati.org/aboutus.htm>).

In the next stage a second panel of experts reviews the full business plans of the remaining firms and meets with the entrepreneurs themselves. Fewer than ten firms each year make it through this stage to be accepted into the incubator. The same panel evolves into an

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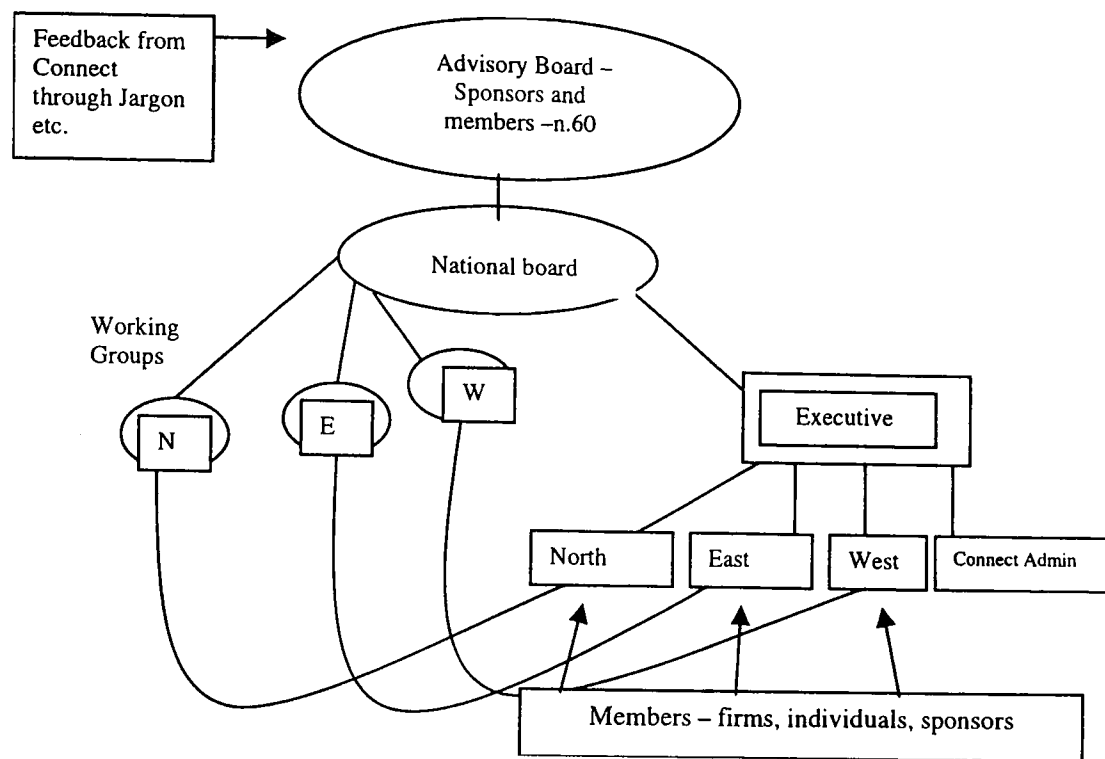


Figure 2. Connect partnership network.

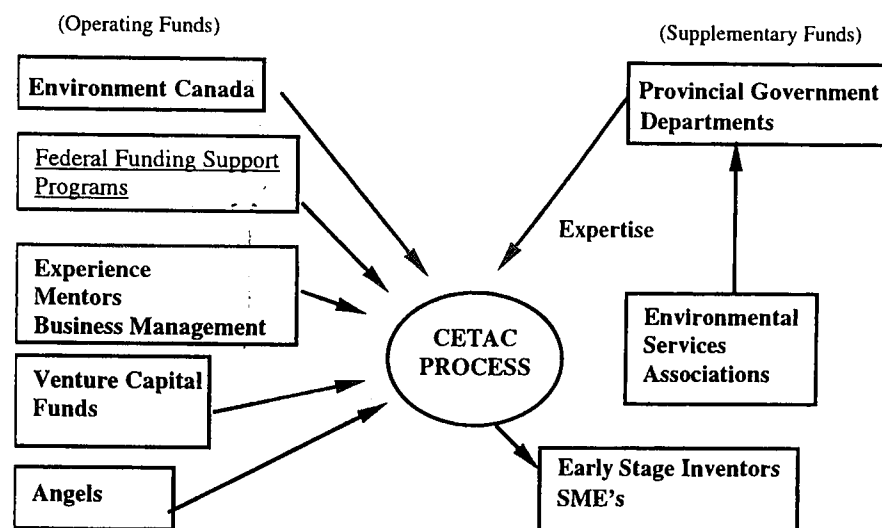


Figure 3. CETAC partnership network.

advisory group with face-to-face feedback with individual managers for an initial phase of 'diagnostics and planning'. ATI staff and members of the various associated networks act as mentors throughout the period of the new firm's stay at the incubator and usually after firms have left.

A range of services are offered to resident firms, as shown in Figure 7. Strategy consultancy by ATI or external experts helps guide the managers of the new venture in terms of

financing, product/ service focus, technological development, market research and so on. HRM assistance covers recruitment, placement of student interns and help with the legal aspects of employment. The ATI also has in-house marketing and public relations expertise and creates publicity for resident firms. One of the central roles is to assist with financing, particularly through membership of The Capital Network.² The ATI provides 'turnkey' office space, telecoms and computing facilities and other necessary

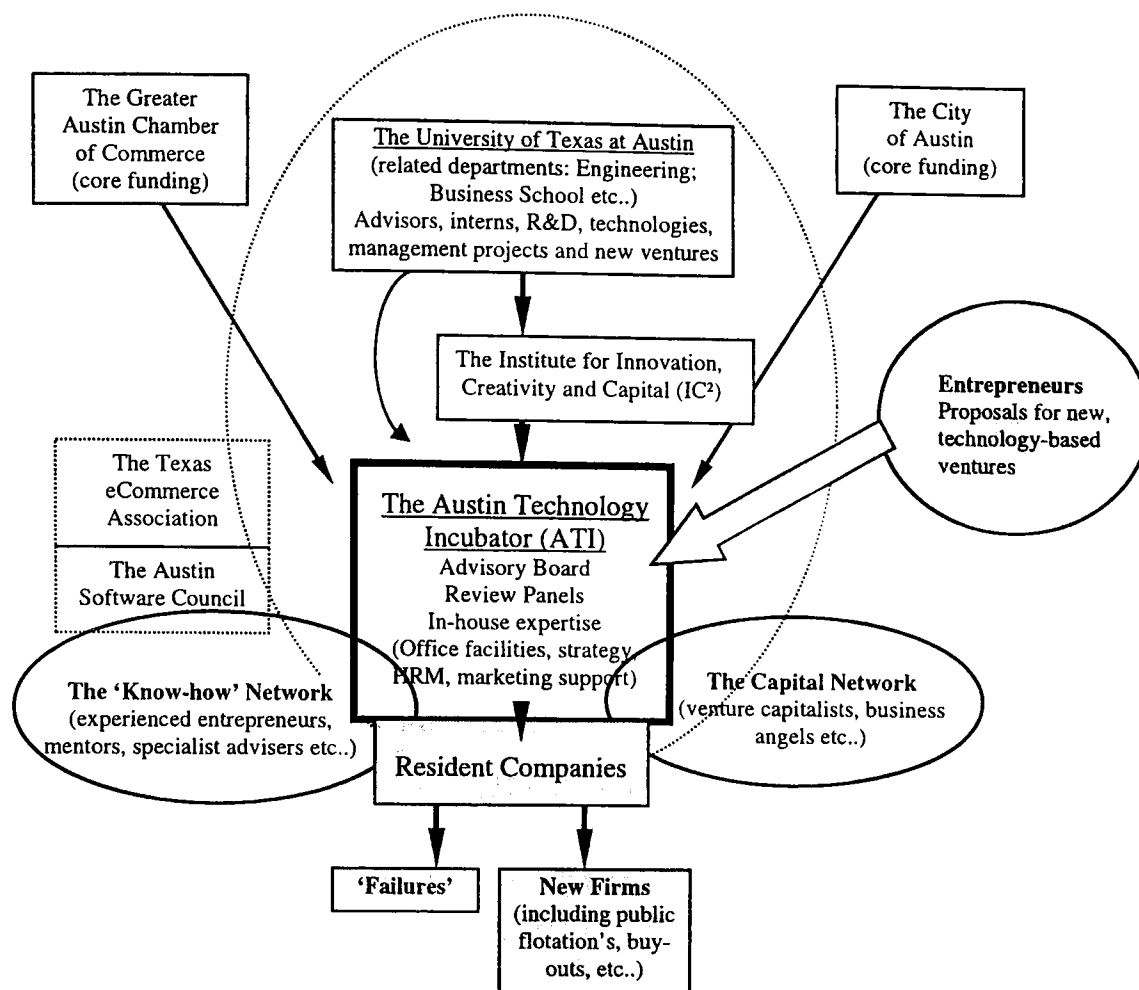


Figure 4. The ATI partnership network.

infrastructure. The 'Know-how Network' is comprised of professional service providers such as IPR lawyers, management consultants, IT services firms and trade advisers, to which resident companies have access. The group of ATI firms generate also some economies of scale from suppliers of shared services and through schemes such as the Technology Incubator Trust, an employee benefits package that covers a number of companies.

In return for all this the ATI charges for office space and hosting the new firms, although costs are generally lower than local rents. The University of Texas at Austin owns the property and loans it to ATI at no cost. ATI brings in other funds to pay for remaining costs, in particular it takes an undisclosed percentage of equity in the firms that it hosts, to 'capture the upside' once they go public.

What makes the ATI much more than an infrastructure-provider is the range of networking events in which resident firms participate. Related

outreach activities and programmes include The Capital Network; The Austin Software Council (set up in 1992); The Austin Multimedia Incubator; The Texas E-commerce Association; the Global Ventures Programme (supporting the international expansion of new firms) and a range of academic networks mainly via IC². These support specialist meetings and events, adding to a more general series of entrepreneurship-related activities.

Norman Caderlan, Director of ATI in 1999, describes the incubator as an 'intellectual venture capital firm', adding value through the intellectual development of enterprises. He lists three major benefits that resident companies gain from the organisation:

1. Credibility through association with ATI. Firms that have passed the ATI selection process are given preferential attention by finance companies and other supporting organisations

Table 4. Connect's operational mechanisms: events.

Type of event	Description	Objective
Technology briefings	Forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies.	To enhance understanding and facilitate technology transfer
Enterprise workshops	Workshops bringing together technology companies and researchers with advisors and business professionals	To develop management skills of both technological entrepreneurs and entrepreneurial technologists
Meet the entrepreneur	Technology entrepreneurs discuss the development of their businesses, their successes and failures and their views of what it takes to succeed.	Learning from the experience of others and discussing development of their own businesses
Springboard workshops	Forum for individual/businesses to present, in confidence, their technological concepts, proposed business strategy or business plans to an appropriate expert panel	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations
Investment conference	Annual venture capital investment conference	To provide the opportunity for technology companies seeking finance to present to an international audience of investors.
Partnership conference	Annual Corporate Partnership Conference present institutional research to an audience of industrialists and businesses (first in March 1998)	To assist in the exploitation of the research through partnerships, joint ventures, new company creation

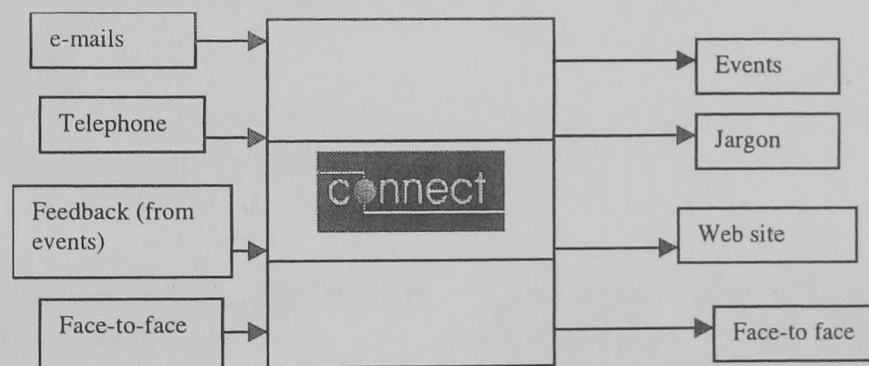


Figure 5. Delivery and communication interface for Connect.

2. Access to the ATI network of expertise and to the other associated local and global networks
3. Faster growth, in that firms make fewer mistakes when they are able to draw on the experience of other entrepreneurs, technical experts, venture capitalists and academics that have studied the commercialisation process.

Results

Connect. Connect has created impact targets focused on three themes:

- number of events and audience mix (stakeholder attendance expected to events);
- number of technology companies securing development/growth funding;

Table 5. CETAC commercialisation model.

Phases → Functions ↓	Concept	Development	Testing	Field Trial	Launch	Review
Management	Champion	Expertise	Team	Leadership	Infrastructure	Profit Centre
Market	Research	Sponsor	Demo.	First Users	Expansion	Competition
Technology	Feasibility	Engineer	Prototype	Pilot	Production	Modification
Finance	Seed	Start-up	Bridge	Revenues	Profits	Sustainability

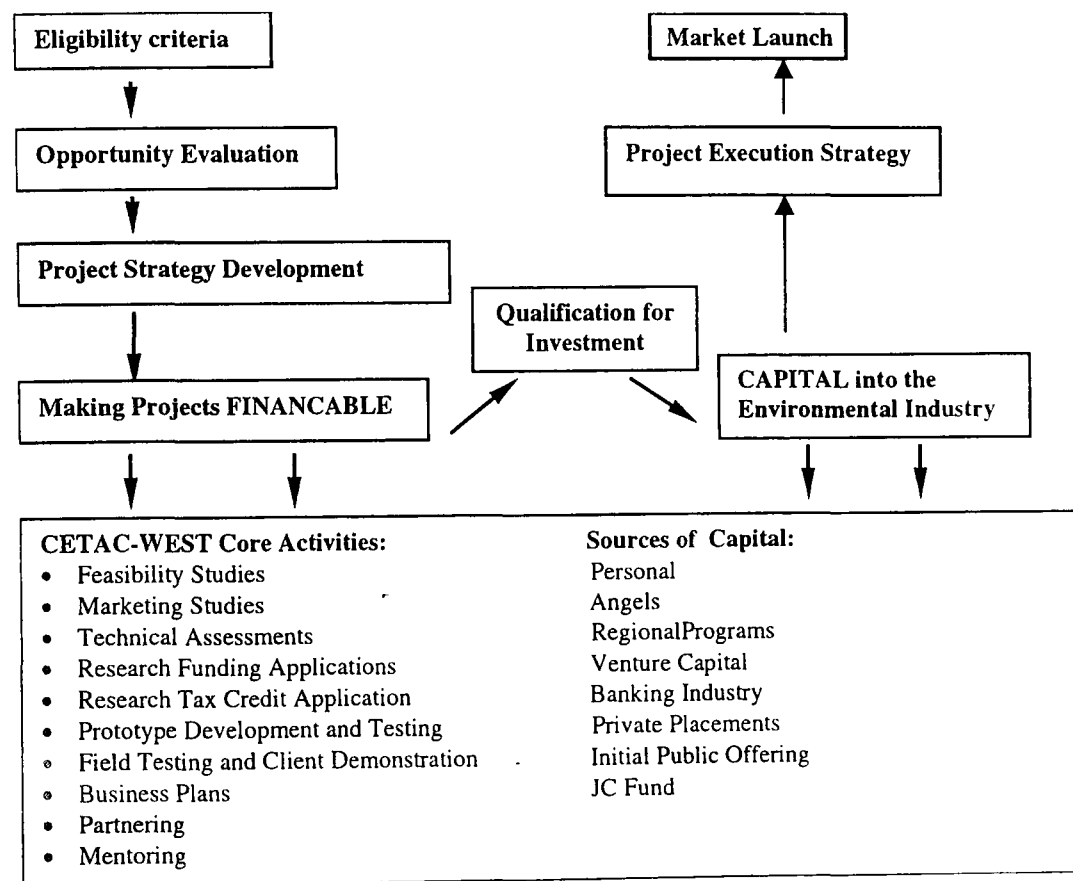


Figure 6. CETAC-west operational mechanisms: core and non-core services.

- number of spin-out companies, collaborations and associated jobs created.

Assessment of the first theme, events and audience mix, for Connect has been relatively straightforward and figures show an increase in number of events (from 27 in 1997 to 49 in 2000) and participants as the Connect network has evolved (Gregson *et al.*, 2000). Assessment of the remaining two themes has been more difficult. This prompted the need to adopt more detailed metrics to understand Connect's impact and value. Three 'value flows', social, knowledge and financial, were identified from Connect's own objectives. These relate to Connect events listed in Table 4.

Participants were surveyed on their rating of the importance of these three value components and their responses are shown in Figure 8 and clearly shows the importance of social value in attending Connect events for all stakeholders.

This suggests that at the time of the evaluation the greatest impact of Connect has been on social networking. This is consistent with the logical evolution of networks where social interactions and acquaintances tend to precede the exchanges and collaborations involving specific knowledge and financial value. A test for the evolution of the Connect programme will be to increase the knowledge and financial value delivered by the programme as perceived by the stakeholders.

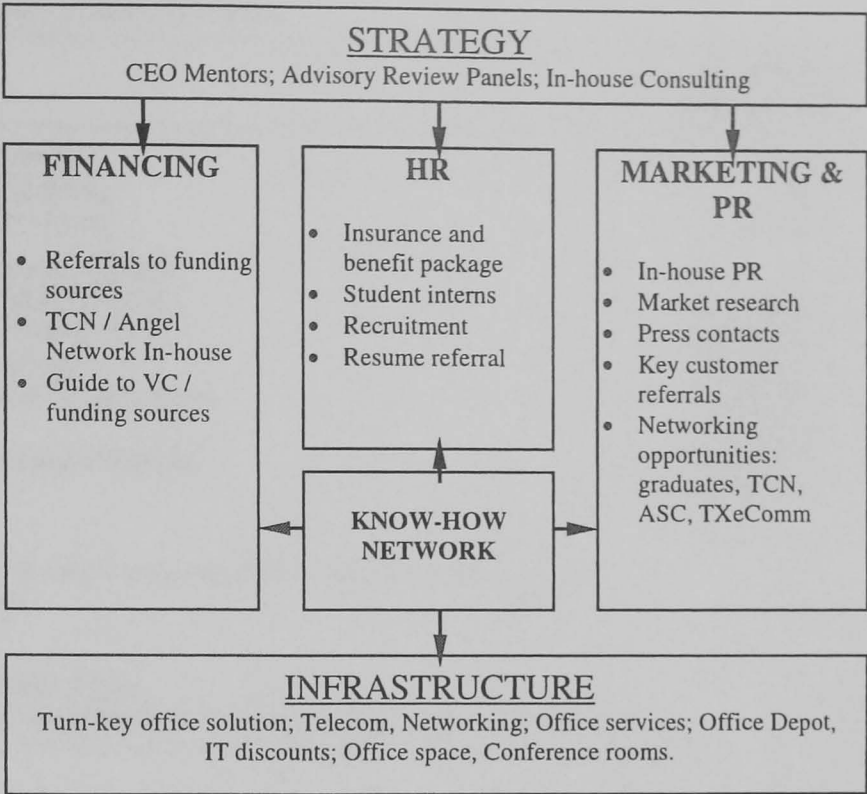


Figure 7. Services provided to resident firms at the ATI.

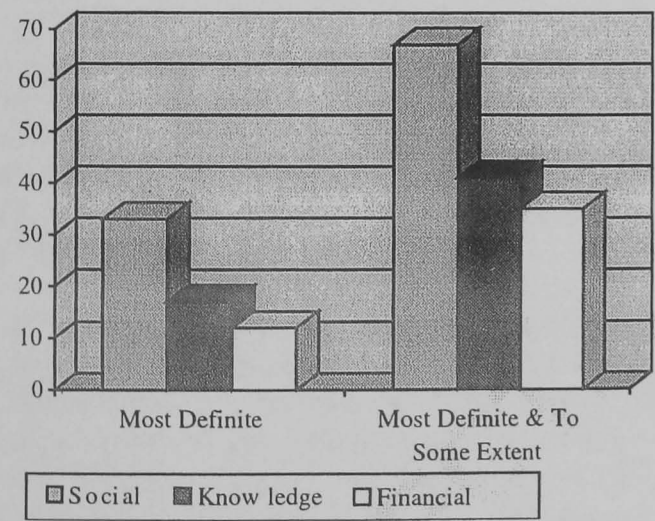


Figure 8. Perceived value (%) from attendance at Connect events (n = 69).

The survey also showed that Connect events were facilitating the transfer of business-related information across sectors and local constituencies. This included ‘market awareness, who are the players, business angels/venture capitalists, etc. and what is innovative in Scotland’. Companies also identified significant value in hearing about other experiences of new business development (Gregson *et al.*, 2000). However, there is little evidence that participants are using the

networking events to actively obtain financial backing or invest in new businesses. This suggests that contacts are being made but investments have not materialised (as yet).

CETAC. CETAC’s impact targets have been primarily financial (left column of Table 6). Similar to Connect it is difficult to determine direct effects of CETAC activities on investment and employment when entrepreneurs are also involved in other networks of support. Delivery of commercialisation services, combined with the comprehensive networking within the investor community, have resulted in achievement of corporate objectives in each of the last four years of CETAC operations. Over 150 new enterprises have become successful ventures, and capital has been raised to the amount of over CDN\$5 million.

CETAC has established a large network of clientele that has facilitated an increasing number of new clients through existing client referrals and the development of repeat business. Taking into consideration those funds directly invested into new ventures as well as all other contracts and support acquired by CETAC, the corporation has leveraged another \$5 million (estimated) for Western Canada’s environmental sector over

Table 6. Financial impact of CETAC (west).

Projects:	Estimated to September 1997	Projected for 2000
Project opportunities reviewed	200	300
Projects developed and pending	150	200
Average project size (per phase)	\$20,000	
Financial benefit to Western Canada:		
Environment Canada funds invested	\$3,455,000	\$1,500,000
Provincial government contribution	\$700,000	
Federal government contracts	\$200,000	
Government and industry contributions	\$500,000	
Private capital raised	\$2,000,000	
Value of partnerships/alliances formed	\$1,500,000	
Export sales generated	\$70,000,000	
Employment:		
Estimated number of full time jobs generated in high technology sector	40	150
Estimated part time jobs	100	100
Leverage:		
Export sales to government funds	20	
Other funds and in-kind contributions to environment Canada Investment	1.5	

and above contributions received from Environment Canada under the initial contract.

CETAC has also assisted certain clients in entering international markets by facilitating strategic alliances, disseminating company information to Canadian embassies around the world, and in one case, supporting a client in his international marketing effort with the result that he negotiated a contract worth approximately CDN\$70 million.

ATI. Compared to the Connect and CETAC-West studies, this research has collected far less objective data on the 'success' of the ATI, or the value it adds to the Austin region. According to Joel Wiggins, Director of Operations at ATI, speaking in September 1999, the ATI enjoys a '90% success rate', but comparable benchmarks are difficult to establish.

The consistent expansion of the organisation and its move in 1995 into a 40,000 sq. ft. dedicated office building for hosting up to 30 new ventures at any one time indicates that it is fulfilling an important role. In its first ten years to 1999, a total of 95 companies have moved in (the longest stay was for three years) and about one-third have left without 'graduating'.

Published data on the ATI states that from 1989 to 2000 its 60 graduate and 19 resident companies have created over 2000 jobs and generated cumulatively over \$900 million in

revenue. ATI firms have raised over \$300 million in capital in 11 years, including five companies that have gone public.

Both the incubator organisation and its resident firms have received public recognition through the years. One firm, 'Exterprise', won the 'National Business Incubation Association's Incubator Client of the Year Award' in the technology category for 2000 and another, 'Infoglide Corporation', received the 'NBIA Outstanding Technology Client of the Year' for 1999. The ATI itself won the 'Randall M. Whaley Incubator of the Year Award' from the NBIA in 1994 and the 1996 'Justin Morrill Award by the Technology Transfer Society'. It has also played a central role in founding three more incubators around the US as well as the Austin Multimedia Incubator in Texas.

The Austin region has enjoyed phenomenal growth of technology-based firms in the 1990s, particularly linked to the evolution of Dell Computers, established by Michael Dell in 1984 while a student at the University of Texas, Austin and now the third-largest PC company in the world.³ The degree to which the ATI, its partner organisations and affiliated networks have contributed to this growth is difficult, if not impossible to measure.

The case of the abovementioned Infoglide, amongst others, does provide some insights into the contribution of ATI. This firm was estab-

lished in 1991 to develop software to search and pattern-match across large, complex databases. After shifting its target market away from police databases to focus on the more promising insurance fraud market Infoglide entered the ATI in 1997. By 1999 it had grown to 30 employees and had received buyout offers in excess of \$100 million in the heyday of 'dot.com fever'. In 2000 it had grown to 75 employees but dropped rapidly to 24 as part of the general collapse of dot.com start-ups, but still managed to attract its third round of venture finance totalling \$21.7 million. It has been seen as a successful, sustainable venture and the founding managers point to a number of critical contributions made by the ATI network.

Beyond office space Infoglide gained support in developing a formal organisation structure and a professional business plan to attract finance. This support partly came from the appointment of an experienced CEO hired through the ATI network, proposed by ATI mentors. This led to enhanced credibility amongst venture capital firms as well as improved connections to a broader range of sources of venture capital. ATI provided additional marketing for the product via its range of publications (particularly when Infoglide software was used successfully to break an insurance fraud ring). Technical partnerships were developed with specialist hardware and software firms via ATI and related IT and software industry network members to aid the development of the core products and help explore market demand for related applications.

Discussion

This study has examined how three organisations, the Austin Technology Incubator (ATI), Texas, CONNECT, Edinburgh, and CETAC-West in Canada have promoted and mediated the connections and interactions between various stakeholders in high-technology entrepreneurship in their respective regions. In their overarching aim to improve business birth-rates and the success of fledgling ventures in their regions they have promoted certain kinds of networking to improve interaction between entrepreneurs and financiers, and various technical, managerial and professional specialists (Stage 1 in Figure 1). In the case of ATI and CETAC-West they have also

established programmes to select likely 'winners' and provide infrastructure and mentoring, specifically guiding enterprises and connecting entrepreneurs with specialist expertise to assist in their successful development.

Obvious differences in the scope, remit and scale of these organisations make direct comparisons less straightforward than we would have liked. This study has effectively mapped out the mechanisms used by the three organisations to stimulate entrepreneurship in the respective regions and provides an insight into important regional differences. Measuring the impact and influence of their market intervention however is problematic, both individually and comparatively.

There is convincing evidence that all three organisations significantly increase interaction between the relevant constituencies responsible for new business development. The range of events organised by these network facilitators, including conferences, seminars, and smaller-scale meetings, alongside their operation as network 'nodes' linking entrepreneurs with various sources of specialist knowledge, increases the volume and variety of regional 'interconnectivity'. This in turn increases the opportunities for the required fusion of entrepreneurs' ideas, complementary technical and market knowledge, managerial knowledge and finance. It maybe impossible to assess the degree to which this connectivity would have evolved in the absence of these organisations. It is also clear that CETAC and the ATI can legitimately claim to have successfully supported the nurturing of new technology-based businesses, but a thorough 'cost-benefit' measurement of the relative contribution to the regional business birth-rate does not appear to be feasible.

Building on the combination of literatures reviewed in this paper our conclusion is that the contribution of these organisations can be best conceptualised by the term '*accelerated learning*'. The ability of local entrepreneurs to continuously and successfully adapt their core technology or product idea to evolving markets, to explore and build partnerships with other technology developers, to make informed assessments of available sources of finance, to find specific sources of advice on the constitution and managerial development of their ventures and in general to fill critical gaps in their own knowledge, has been

enhanced by the activities of Connect in Scotland, the ATI in Texas and CETAC-West in Canada. The 'integrative capabilities' of local entrepreneurs, their ability to search, filter, assimilate and integrate knowledge from a huge variety of sources has been improved by the activities of these three organisations. The huge 'transaction costs' which make the learning curve that much steeper and the process of reputation-building so much harder for such firms are *subsidised* through their access to these established and credible networks and continuous networking activities.

At the policy level therefore we support the view that although it is 'unrealistic' to assume that firms will cluster around universities (Malecki, 1997), university-based organisations like these make a positive contribution to the 'triple-helix' (Debackere and Van Looy, 2001), linking centres of knowledge to business and government agencies. Combining this with the above conclusion that a cost-benefit assessment of the public money that goes into such initiatives may not even be possible leaves regional development agencies with something of a dilemma. The enthusiasm amongst policymakers across the developed and less-developed world for pouring efforts and resources into stimulating local high-technology clusters may only be justifiable as a 'leap of faith'.

Beyond the activities of these organisations, however, the relative strengths and weaknesses of both kinds of networks depicted in Figure 1 underpin the overall potential of the innovation systems in these respective regions. This includes what has been termed 'institutional thickness' in the literature (Malecki and Oinas, 1999) which influences the volume and variety of entrepreneurial learning that can take place locally. In the case of Scotland, this comparison supports other studies that show some important weaknesses in the region. These include a lack of venture capital and inadequate mechanisms for investing in small firms, a shortage of small firm management expertise in strategic high-technology sectors, a lack of interaction and common purpose between academia and industry, and a weak 'entrepreneurial culture' (Collinson, 2000; Danson, 1996; Reid, 1997, Scottish Enterprise, 1999). The question of whether the requisite 'critical mass' of particular knowledge and expertise can ever evolve in the Scottish region, regardless of the

activities of agencies like Connect remains a real issue.

Further important regional differences were highlighted in this study, providing insights into the relative effectiveness of and limits to the network-building activities of the organisations studied. It is clear that Connect, based at the University of Edinburgh, could evolve to take on the role of a 'Stage 2' and 'Stage 3' organisation, selecting, mentoring and incubating high-potential enterprises in the style of the university-based ATI. The 'arms-length' relationship between academia and industry in Scotland, compared to the USA, however is likely to limit its effectiveness in such a role.

An important cultural and institutional characteristic underpinning the success of ATI, according to interviewees, is the ease of interaction, knowledge-exchange and network development between the University of Texas at Austin, local entrepreneurs and local industry (and regional government agencies). Moreover, an obvious 'gel' creating the sense of common purpose and the impetus to build connections lies in the way participants commonly take equity stakes in new ventures. Shares in new ventures are sometimes a direct reward for contributing valuable or 'tradable' knowledge and expertise, or for providing infrastructure and facilities, as in the case of the ATI (and ultimately its owner, the University of Texas). Alternatively network participants may make personal investments alongside professional venture capitalists, guided by their direct knowledge of emerging ventures gained through networking activities (Mason and Harrison, 1996). Social capital and specific contributions of useful knowledge are rewarded with 'privileged' access to investment intelligence. Without equity participation academics in the Scottish context have little or no incentive to contribute to commercialisation activities and University institutions actively maintain barriers with industry, to retain their independence.

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Notes

1. Notification of events is sent out through *Jargon*, the Connect newsletter that keeps members and sponsors abreast of developments and news regarding events, workshops etc.
2. The Capital Network is seen as one of the most important connections. At its centre is a 'match-making' service which uses a database of investors, listing their profiles and their ideal target firms, to whom entrepreneurs send proposals. The Capital Network organises a range of Venture Capital conferences where 20–25 companies are selected to present to potential financiers. IC² and the ATI put forward companies and help entrepreneurs structure their proposals and presentations. Education programmes in association with the University of Texas at Austin help entrepreneurs develop business planning and management capabilities (often targeted at helping 'technologists manage').
3. In this decade the region added 'more information technology jobs than Silicon Valley; Boston's Route 128; or Research Triangle, North Carolina'. The November 23, 1998, issue of *Fortune* ranked Austin #1 as the 'Best US city for business and wealth creation', cited for fostering entrepreneurship. Austin's technology-based economy centres on electronics and semiconductors, computers and peripherals, and software, with emerging strengths in the film and music industries, multimedia, biomedical products, logistics and distribution, and transaction services. With three billion-dollar plants, Austin has the largest concentration of semiconductor production in the USA. The Greater Austin Region has the highest rate of patent filings per capita in the USA and of the 57 publicly held companies in Austin, 32 have staged their IPOs since 1994 (<http://www.ic2.org>). Please supply the details. Please supply the details.

Real-time evaluation methodology as learning instrument in high-technology SME support networks

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Abstract: This paper focuses on the philosophy and implementation of an evaluation approach used as a learning instrument in the evolution of a major enterprise support network in the UK: Connect Scotland. The Connect real-time evaluation methodology has distinguished and assessed the value flows delivered by the program as perceived by its stakeholders. It has done so not in a *post-mortem* fashion but in real-time fashion (i.e., during the program), with the aim of capturing strengths and weaknesses and contributing to its further development.

The paper discusses the importance of support networks for enterprise development then looks at some of the concepts and limitations facing the evaluation of enterprise support networks. This is followed by a detailed analysis of the real-time evaluation methodology used in Connect Scotland, including an examination of the Connect program itself. The paper then summarises the key results of the value-flows of Connect as perceived by the stakeholders, before ending with a discussion on value for money and key recommendations.

Keywords: SME support networks; real-time evaluation methodology; constituency-building; value flows; CONNECT constituency

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Biographical notes: **AUTHORS: PLEASE PROVIDE BRIEF BIOGRAPHICAL NOTES (APPROX. 100 WORDS)**

1 Introduction

This paper focuses on the philosophy and implementation of an evaluation approach used as a learning instrument in the evolution of a major enterprise support network in the UK: Connect Scotland. The Connect real-time evaluation methodology has distinguished and assessed the value flows delivered by the program as perceived by its stakeholders. It has done so not in a *post-mortem* fashion (i.e., after the end of the program) but in real-time fashion (i.e., during the program), with the aim of capturing strengths and weaknesses and contributing to its further development.

The structure of the paper, first, discusses briefly the importance of support networks for enterprise development, then looks at some of the concepts and limitations facing the evaluation of enterprise support networks. This is followed by a detailed analysis of the real-time evaluation methodology used in Connect Scotland, including an examination of the Connect program itself. A further section summarises the key results of the value-flows of Connect as perceived by the stakeholders. The paper ends with a discussion on value for money and key recommendations.

2 Rationale for support programs

In recent years, there has been a proliferation of support programs for stimulating the formation of new technology ventures in many countries. Amongst the best known are the Austin Texas incubator, the Connect San Diego and the industrial cluster programs of the Basque Country (Spain) and Scotland. The frequent target for these initiatives is the high technology sector, viewed by policy-makers as promissory of major long-term economic benefits. High technology companies are perceived as having greater growth potential than conventional firms that can lead to significant regional economic prosperity [1-3]. High technology firms have also been viewed as corrective for unemployment caused by the decline in traditional industries [4].

The most common argument used to justify support programs is the high rates of business start-ups that experience early failure. Factors that contribute to failure can be seen at both the firm level and in the external environment. At the firm level, commercialisation complexities in starting a high technology company, it is argued, require specific supportive mechanisms that not only improve survival but lead to growth. More start-up successes and growing firms can result in increased employment, a stronger high technology sector and spillover effects that combine to contribute to economic prosperity. Failure at the external level relates to lack of supportive elements for firms. Research on successful high technology regions, such as Silicon Valley, Cambridge, UK and Cambridge, Massachusetts points out the critical importance of a supportive infrastructure for new and growing firms. These elements include tax incentives, the provision of business parks and programs that facilitate supportive agents that understand the needs and requirements of emerging and existing firms. Government intervention, it is argued, is required that stimulates creation of supportive agents and thus a critical mass of competitive firms can be established that make an impact on the regional economy.

3 Enterprise support networks

The stimulation of 'enterprise support networks' is a common strategy designed to create and develop a supportive infrastructure for high technology companies, or an 'entrepreneurial infrastructure' [5]. It is based on entrepreneurial network theory that suggests that strength, complexity and diversity of business relationships influence newly formed firm performance, resulting in improvement of the longer term chances of firm survival and growth [6].

Similarly, the literature on 'industrial districts' puts forward the argument that there are a certain number of invisible factors that are favourable to economic development, such as the constitution of networks and the development of confidence and close relationships between firms [7]. Malechi and Todtling [8] assert that network creation is a growing policy prescription for regions where networks have failed to emerge.

A body of research literature stresses the importance of informal social contact as a starting point to knowledge acquisition for the entrepreneur. Initial contacts from social networks evolve into business-focused networks, and then into strategic networks, which allow firms to innovate and to thrive by their links to other organizations [9-12].

Monsted [13] distinguishes between three types of networks, with each serving a different function for the entrepreneur:

- 1 networks for service and assistance;
- 2 networks for information and structuring, particularly for knowledge about whom to contact for a specific purpose; and
- 3 networks for entrepreneurship and product development.

Sanberg and Logan [14] found that an entrepreneur's 'network' really comprises multiple networks defined by the resources each network provides. They argue that the entrepreneur who fails to make this distinction, directing energies toward developing an undifferentiated "network", is less likely to acquire critical resources than is one who targets their most effective sources. One question that Sanberg and Logan propose is not whether networks are required for co-ordination, but under what conditions they work best. Larson (1991) found that the entrepreneurial firm's ability to identify, cultivate and manage a network partnership is an essential condition for survival and success.

A body of research has shown that entrepreneurs gain access to resources and information through their networks to start-up, develop and grow enterprises [10,16,17,18]. In addition to a supply of resources, networks provide social support and self-confidence and strategic capacity to learn and organise for new activities [18]. Best [19] suggests that networks are preferable to markets because they involve more social contact and encourage information to be shared, they are more co-operative and less competitive and they reinforce the sense of mutual obligation on which society depends.

Pihkala *et al* [20] suggest that networking involves a variety of capabilities, including communicating skills, cooperativeness, ability to share a vision, trust, ability to act as a network broker, customer orientation, ability to use market information, knowledge of cooperative agreements and market orientation. Many of the higher order competencies required to operate a successful new venture are learned from other successful businesses. Previous entrepreneurs may share their knowledge that is essential in

operating a business, such as regulations, taxes, accounting, suppliers, customers, and marketing and distribution.

Networks may be particularly important at the start-up phase. Starr and MacMillan argue that the entrepreneur needs to mobilise 'social resources' because of liabilities that include size, lack of market legitimacy and newness. Sharman *et al* [21] state that, for entrepreneurial ventures, networks can contribute positively to gaining organisational legitimacy and to developing a desirable marketplace reputation.

4 Evaluating support networks

Much of the debate over support for high technology questions the effectiveness of support strategies. While difficult to quantify, the quality and the value added by support initiatives reflect great variation from country to country, and even from location to location in a given country [1]. These authors suggest that there is a need to compile and publicise the 'best practices' in each country and internationally, to provide a benchmark, and also to avoid duplication of effort and control confusing signals from the myriad of entities operating in this field.

There is little evaluation research specifically on constituency-building or network programs [22] similar to Connect Scotland, despite the fact that many have been operating for over a decade in high technology 'regions' of North America and Western Europe. Johannisson [22] points out a number of methodological problems associated with analysing networks. He suggests that networks are often taken for granted and not fully appreciated, in part because of the social or informal character of many networks. A related issue is the difficulties in establishing a causal relationship between networking and enterprise performance.

A key factor in evaluating program effectiveness is the purpose and motivation for evaluation. An evaluation methodology for any intervention program requires a defined purpose as well as scaleable and appropriate assessment objectives. Different organisations may have different motives for undertaking and commissioning evaluations. Public accountability may emphasise a cost-benefit analysis and level of performance measurement for program delivery.

Much evaluation research has arisen from a rather narrowly based concern to ensure that public program represent 'good' value for money. Many evaluations are concerned fundamentally with assessing the success or failure of programs [24]. Few evaluations are able to provide definitive evidence regarding 'success', mainly because of the complexity of methodological issues that confront researchers, according to Gregory and Martin [3]. Success may be determined in absolute or differential terms. The measurement of impacts present particular problems because of the way in which evaluators adopt various definitions of what constitutes success, i.e., job creation, firm growth or firm survival rates.

Deakins *et al.* [2] note that research on business development support programs is too often carried out retrospectively; giving little or no opportunity to compare the differences that such support has made to the objectives and managerial ability of clients involved in the program of support. In the same vein, studies of support programs have pointed to a consistent lack of internal monitoring and information-gathering mechanisms that make it very difficult to evaluate results and impacts.

Alford [25] stresses that evaluators require high quality primary data, and the program administrators rarely assemble it adequately. Few program evaluations have included both qualitative and quantitative measures of 'process-oriented' outcomes and as a result some evaluators have found themselves unable to advise on improving program design to enhance effectiveness [3]. Individuals and groups may require evaluation systems that continually audit the delivery of services and their outcomes, and provide evidence of effectiveness to aid in their decision-making [24].

Patton [26] points out that process evaluations are aimed at understanding the internal dynamics of program operations, and typically require a detailed description of program operations. Process analysis asks how the program works with emphasis on identifying ways of improving program design and delivery, and is typically qualitative in approach [27]. A process evaluation requires sensitivity to both qualitative and quantitative change in programs throughout their development, and means becoming intimately acquainted with the details of the program [26].

Patton suggests that process evaluations permit decision makers and information users to understand the dynamics of program operations, shedding light on the extent to which the program is operating the way it is supposed to be operating. They are also useful for revealing areas in which programs can be improved as well as highlighting those strengths that should be preserved. Patton cites two other uses of process evaluations. They permit people not intimately involved in the program-external funders, public officials and external agencies-to understand how the program operates. As well, they are particularly useful for dissemination and replication of programs under conditions where a program has served as a demonstration project or is considered to be a model worthy of replication at another site. The real-time evaluation of Connect Scotland offers a particular way of realising the spirit of process evaluation.

4.1 Some basic criteria for program evaluation

An analysis of the evaluation literature concerned with support programs shows that there are at least four major criteria to be fulfilled in a process evaluation. These are:

- 1 An evaluation methodology for any support program requires a defined purpose as well as scaleable and appropriate assessment objectives in terms of both process and outcomes.
- 2 A process evaluation requires sensitivity to both qualitative and quantitative change in programs throughout their development, and means becoming intimately acquainted with the details of the program.
- 3 If the results of an evaluation are to gain widespread acceptance and credibility in the public domain, it is essential that a full range of stakeholder perspectives be incorporated into the research design. This suggests incorporating a measure of the 'value' that stakeholders perceive from exposure to the program, and preferably how that perceived value changes over the time of the program.
- 4 If a phenomenon under investigation is complex, information-rich cases are useful in learning a great deal about issues of central importance to the purpose of the evaluation. This is difficult to achieve and requires a level of analysis that focuses on each company (micro-firm level).

Drawing together evaluation results, establishing effectiveness and credibility and improving the program's delivery and process are seen as important challenges for most evaluations. As we shall see, the real-time evaluation of Connect Scotland tries to incorporate all these criteria in its design and implementation. Before entering into the discussion on the methodology, however, the paper will review the rise and development of the Connect Scotland constituency.

5 Rise, development, aims and mechanisms of the Connect Scotland Program

5.1 Origin of Connect Scotland concept

Connect is a story of transfer of entrepreneurship; its origins have evolved from Connect San Diego. In February of 1995 Ian MacDonald had an initial idea of researching US business links and support programs as part of his PhD. This research took him to Washington DC, where MacDonald first heard of a project operating in San Diego called Connect. He got in touch with the Connect San Diego Program Director, Dr. Abigail Barrow, who had spent some time working and researching in Edinburgh. From this meeting, it was proposed that in a further visit to the US, MacDonald would visit Connect in San Diego. Upon his return to the US, he spent a month interviewing various individuals involved with the Connect network. This research gave rise to the strong opinion by MacDonald that a similar style of organisation could play a significant role within the Scottish business arena.

Initial efforts began in January 1996, focusing on creating both awareness and support for a Scottish version of the original San Diego Connect project. One of the first people Ian sought for consul and discussion on the concept was Martin Ritchie, a successful Scottish entrepreneur whose support, MacDonald thought, would provide initial credibility in developing a supportive infrastructure in this critical early stage. From this point, founding sponsors were identified and secured, largely drawn from the private sector. Connect found a home at the Management School following strong support from the University of Edinburgh. In their interviews, both MacDonald and Martin Ritchie allude to the critical support from Sir Stewart Sutherland, the Principal of the University of Edinburgh, who facilitated Connect locating the program at the Management School.

5.2 Initial Connect's formalisation steps

The initial steps of formalising the creation of the Connect program were taken in 1995 at the University of Edinburgh. In 1996, a proposal was submitted to the Scottish Higher Education Funding Council (SHEFC) [28] for the start of a pilot program of activity and events initially focused on the Lothian and Fife region. In this 1996 proposal, it was made clear that the intention was for the activities of Connect to be eventually extended to other regions within Scotland. This intention was realised through a further proposal in 1997, with the result that the program expanded nationally to become Connect Scotland [29].

The Connect concept conformed to one of the key themes in SHEFC's 1995 Corporate Plan, namely, "to develop the responsiveness and vitality of the research base

in Scottish higher education, and to work with higher education institutions and other agencies in contributing to economic competitiveness and the quality of life." More specifically it conformed to a critical objective within this theme, "to develop further links between Scottish higher education institutions and industry and commerce" [29]. Most importantly, the development of a Connect program in Scotland was a central recommendation given in the Technology Ventures strategy document published on 28 August 1996.

This document built on the earlier Commercialisation Enquiry conducted by Scottish Enterprise (SE) and the Royal Society of Edinburgh (RSE) and identified a wide range of factors requiring attention to help nurture a technology ventures culture and economy in Scotland. It also proposed avenues to tackle the problem, amongst them, the establishment of "a networking and business support infrastructure to generate effective academic-industry links facilitating the multi-directional flow of information between academia, companies and service providers. Connect at the University of California, San Diego, may be an appropriate model" [30]. The development of Connect in Scotland constitutes a clear answer to this recommendation and the "vision is to create and develop a program that will have an impact in Scotland similar to that of the Connect program in San Diego" [29, p.4].

Thus, Connect was developed against a background of the Technology Ventures Strategy. Technology Ventures' broad aim is to establish new businesses and jobs within Scotland and is based at Scottish Enterprise. Technology Ventures itself was created as a result of a Commercialisation Enquiry conducted jointly by the Scottish Office and the Royal Society of Edinburgh.

Today, Connect Scotland is supported by Technology Ventures, the Royal Society of Edinburgh, the Scottish Office Education and Industry Department and the Scottish Higher Education Funding Council.

5.3 Connect's objectives

Since its inception, Connect set for itself an ambitious mission:

"To support the creation, development and growth of technology-based enterprise throughout Scotland".

The above mission was to be achieved through a program of activities and events facilitating and encouraging interactions between the university sector, large corporations, emerging companies, service providers, regional government, economic development agencies and support groups. The program was to bring together a wide variety of communities, including entrepreneurs, technologists, scientists, banks, equity capital providers, business consultants, accountants, lawyers and policy-makers, helping to bridge the knowledge gap existing between these communities.

Connect's mission followed the rationale that interaction between these communities is critical for the development of high growth and high technology enterprises [29]. It also followed the findings and recommendations of enquiries and policies of key Scottish industrial and academic institutions, including Scottish Enterprise, SHEFC and the Royal Society.

To a large extent Connect Scotland set for itself a fundamental challenge for this Scottish knowledge economy namely to "stimulate a resource and expertise environment for interaction, learning and opportunities for different communities interested in the

development of technology-based ventures and, ultimately, economic growth". Bridging of the knowledge gap existing between these different communities is central to this purpose and relates to the Connect's six key objectives, as listed below:

- 1 Develop and educate an expert infrastructure that understands and supports the needs of technology-based ventures, giving companies access to a network of expertise and resources essential to their success in a global market-place.
- 2 Facilitate and support the transfer of technology from the Scottish science base to new and existing firms, either by spin-out or through collaborative projects.
- 3 Complement specific initiatives in individual agencies and organisations, providing a resource that can be used by all participants to promote and develop related activities and projects [32].
- 4 Enhance the ability of new and existing firms to secure finance.
- 5 Educate entrepreneurs about business development and issues germane to their industries.
- 6 Help entrepreneurs to define new businesses and whether they should start them.

5.4 Connect Organisation and delivery and communication channels

Connect as a networking organisation is involved in managing and propagating communication through its events, which is the primary responsibility of Connect staff. Logistical and administrative activities for event delivery are major work tasks, followed up by event facilitation that ultimately provides the interface between Connect and its stakeholder constituency.

Notification of events is sent out – through Jargon - a newsletter that keeps members and sponsors abreast of developments and news regarding events, workshops etc.

An important aspect of recruiting new company members is scanning a variety of sources for companies that Connect staff views as relevant for membership. The Connect database of contact firms is thus constantly expanding.

Figure 1 provides an approximation of the Connect network. Starting from the bottom right are all the members of the Connect constituency: firms, sponsors, individuals, etc. who are scattered across North, East and West of the country. Sponsors may be private service providers, technology companies, enterprise agencies and they pay a £3000 fee. Virtually all Scottish universities are also sponsors. Individuals are attendants to events who have no organisational affiliation and firms may be non-sponsor technology companies who are either paying members (at £150 each) or non-paying members. These stakeholders have regional working groups as shown to the left of Figure 1 and they can form part of the Connect Executive or National Board, where they interact more closely with the Connect Administration. The entire process is guided by the Connect's Advisory Board, made up by sponsors and regional working groups who are instrumental in developing the array of topics for the events.

Figure 1 Connect organizational network [33]

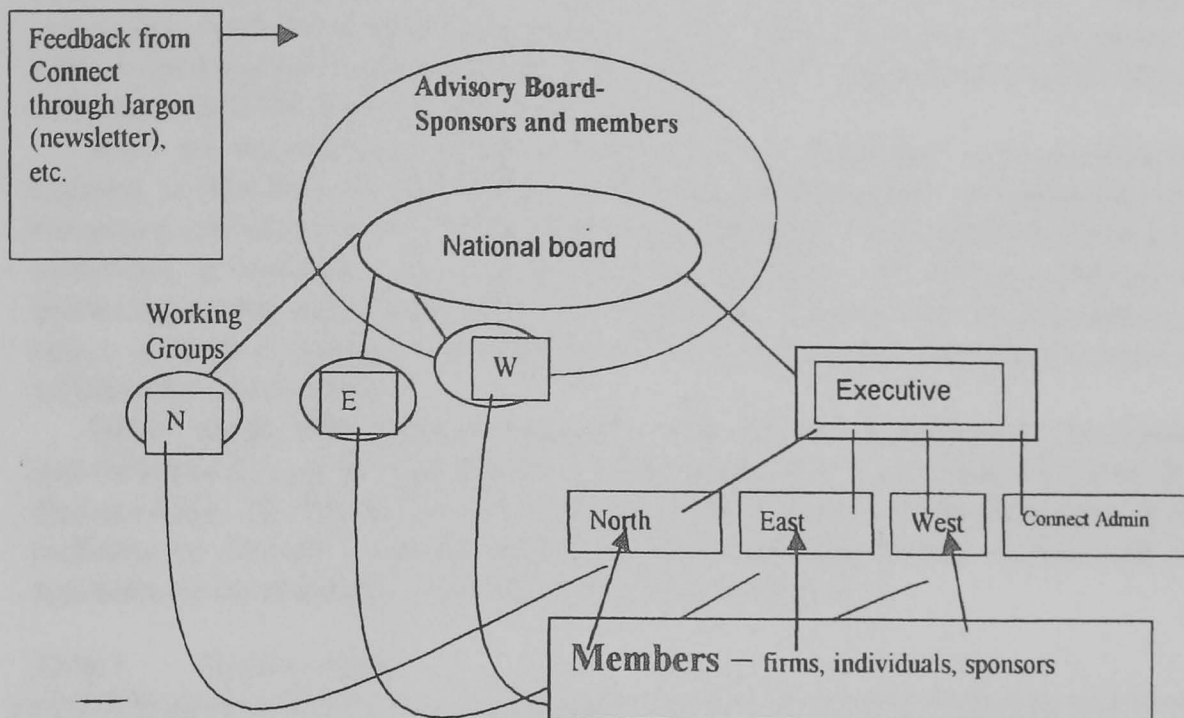
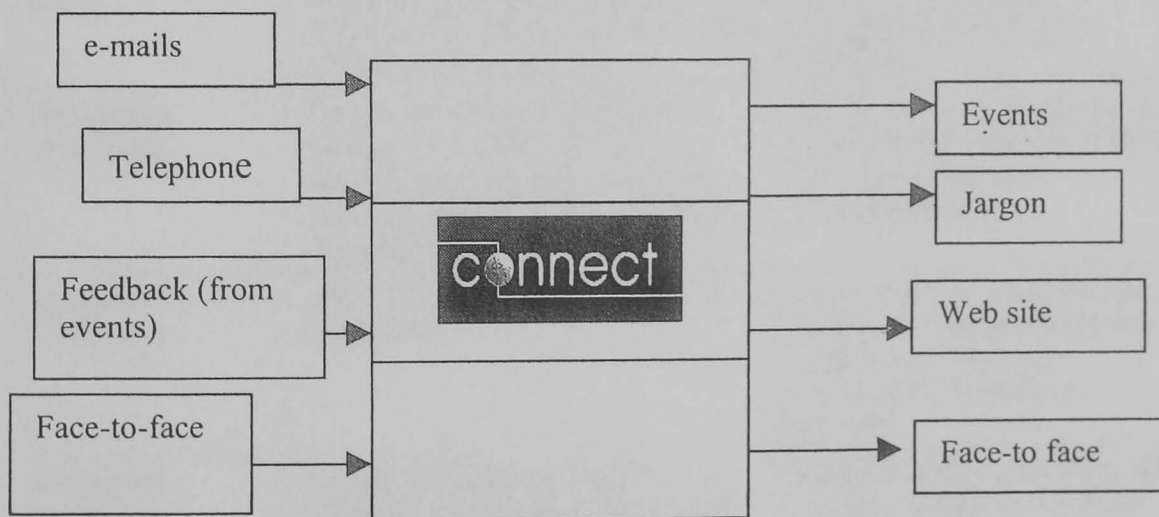


Figure 2 illustrates the range the delivery and communication interface and feedback processes used by Connect. Most of the items are self-explanatory with exception of Jargon that is the newsletter of Connect.

Figure 2 Delivery and communication interface for Connect



5.5 Connect's support mechanisms (activities and events)

Table 1 shows the activities and events that includes briefings, lectures, courses, workshops, conferences, technical and social support. The six Connect events shown in Table 1 are expected to play a specific purpose for specific target audiences and they all combine to fulfil the targets of the overall program.

There are three recurring types of events that are considered core activities for Connect, in that they are intended to involve the greatest number of participants and maintain a continuous flow of learning among stakeholders: These events are *enterprise workshops*, *an audience with...*, and *technology briefings* – the first two focused on enhancing general managerial skills and stimulating learning from the experience of others, whereas *technology briefings* provide a forum for actual business processes of collaboration to be initiated.

Table 1 shows three additional types of events: two annual conferences (Investment and Partnership) and the Springboard Workshop delivered on a flexible but less than frequent basis. The first three core events are the main subject of the first-phase on the evolution of Connect, with the others left for future examination, in line with the scalability of the proposed methodology (see below section 6).

Table 1 Connect's events

Type of Event	Description	Objective
Technology briefings	Forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies.	To enhance understanding and facilitate technology transfer
Enterprise Workshops	Workshops bringing together technology companies and researchers with advisors and business professionals	To develop management skills of both technological entrepreneurs and entrepreneurial technologists
"An Audience with..."	Technology entrepreneurs discuss the development of their businesses, their successes and failures and their views of what it takes to succeed.	Learning from the experience of others and discussing development of their own businesses
Springboard Workshops	Forum for individual/businesses to present, in confidence, their technological concepts, proposed business strategy or business plans to an appropriate expert panel	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations
Investment Conference	Annual venture capital investment conference	To provide the opportunity for technology companies seeking finance to present to an international audience of investors.
Partnership Conference	Annual Corporate Partnership Conference will present institutional research to an audience of industrialists and businesses (1st in March 1998)	To assist in the exploitation of the research through partnerships, joint ventures, new company creation

5.6 Connect's committed targets

At the start of its events and activities, Connect set for itself a number of quantitative and qualitative targets. These are shown in Table 2 and are the original targets established for Connect's first four years of operation, 1997-2000.

Table 2 Quantifiable targets for Connect's outputs and impacts (up to end of year 200)

<i>Key Indicators</i>	<i>Quantifiable Targets</i>
No. of events held	-At least 162 events; minimum of 25 participants per event; target mix is 50% technology ventures; 30% academics and 20% business professionals
No. of technology ventures participating in events	-At least 180 new and emerging technology companies will attend the mix of workshops and briefings; - <i>Learning achieved will significantly enhance the ability of participating companies to increase their rate of sustainable growth</i> -Quality target is 75% of participants to rate the event as "good" or better on a scale measuring the perceived value of the event to the business/individual
No. of collaborative projects	-At least 216 academics/research staff will attend the mix of events -At least 45 collaborative projects between technology ventures and university/research centres to be established in the project period
No. of technology ventures securing funding	-At least 40 technology companies will secure developmental/growth funding - <i>Pilot has already established that technology ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance</i>
No. of spin-out companies formed	-Connect will facilitate and enable the creation of 15 spin-out companies from the Scottish science base and established technology companies - <i>Participation in Connect is likely to improve the survival and growth rate of any spin-out company</i>
No. of new jobs	-Minimum of 180 new high income jobs enabled by Connect

Connect's committed targets contain six key indicators with quantifiable targets and are focused on three themes:

- number of events and audience mix (stakeholder attendance expected to events)
- number of technology companies securing development/growth funding
- number of spin-out companies, collaborations and associated jobs created

From Table 2, it can be seen that the nature of the committed targets increases in difficulty as one moves down the table. Delivering a specific number of events, for example, is much easier than demonstrating that a minimum of 180 new high-income jobs were enabled by Connect. Yet the evaluation of Connect must strive to account for both.

6 Real-time evaluation methodology for Connect Scotland

“... From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years.”

(Ian MacDonald, Director of Connect, 1997)

Connect has a broad mandate to develop a supportive infrastructure for high technology companies, or an ‘entrepreneurial infrastructure’. Connect is a unique support program with its own particularities and characteristics. No off-the-shelf recipe exists to evaluate a program such as Connect. This section describes the main tenets of the real-time evaluation methodology applied to the Connect Scotland program.

6.1 Purpose and ingredients of real-time evaluation

It should be first stressed that the defined purpose of the evaluation of Connect is not an arms-length *post-mortem* evaluation. It is indeed intended and designed to contribute to the development of the program by making explicit achievements, difficulties, challenges and weaknesses, with the results fed back into the evolving constituency. In short, the Connect evaluation is, in itself, an explicit learning factor of the program.

In addition, in line with the findings of the literature, the real-time evaluation of Connect is longitudinal, process-oriented and flexible. It includes assessment of achievements against committed targets, but it does not focus exclusively on them, since such a focus is not revealing of the development of a supportive infrastructure and the actual value added by the program. Indeed, it must be taken into account that Connect is fundamentally about ‘connecting’ and stimulating social, financial and knowledge flows. But Connect itself does not pursue the formal and systematic mentoring or nurturing of a newly emerging venture, collaboration or potential spin off. In this respect, Connect has no direct control of processes leading to new or increased numbers of collaborative projects, technology ventures securing funding, spin out companies, or new jobs. This means that exclusive focus on committed target suffers from a gap in the understanding of the processes between event participation and significant new venture creation. It seems to be assumed that such intermediate processes have simply happened if committed targets such as the creation of spinouts occur with clear reference an initial stakeholder ‘connection’ stimulated by Connect. A longitudinal, process-oriented methodology should take care of such a ‘process gap’, particularly by capturing the experience of emerging ventures through case study at firm level.

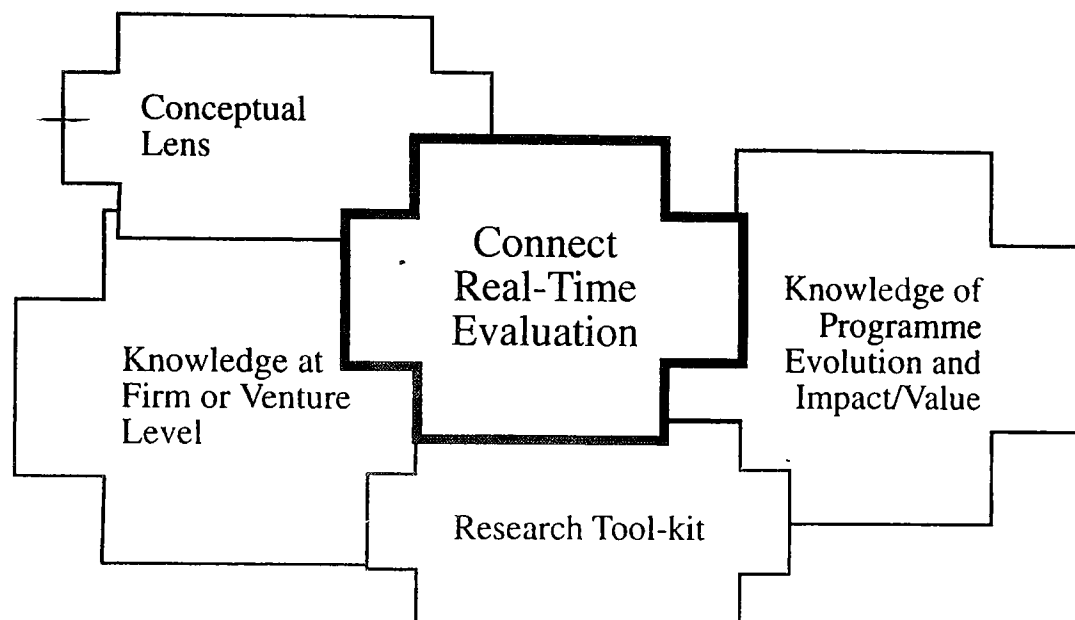
The real time evaluation of Connect integrates four major complementary ingredients illustrated in the ‘methodological jigsaw’ of Figure 3.

- A conceptual lens to make sense of the complexities and multiple elements involved in the Connect constituency building process. This framework enables an appropriate organisation of the problem together with continual information gathering for evolutionary analysis of Connect’s objectives related to effect on stakeholders
- Knowledge on the evolution of the Connect constituency at program level. This looks at two aspects: (a) the origins and development of the Connect program revealing what has happened with the implementation of its core activities and (b) the value-added delivered by the Connect program with reference to its original objectives and as judged by its stakeholders. Three types of value flows are

distinguished: social, knowledge and financial flows, each offering a gradation of possible outcomes from 'easier' to 'more demanding' to achieve. The two aspects complement each other to generate a picture of the development of Connect's and its impact with reference to the program's committed qualitative and quantitative targets.

- Knowledge of ways in which Connect's activities is having an influence at individual firm or venture levels. These 'best-practice' cases complement the findings of the program level by seeking to reveal where and how Connect's value is realised through the experiences of specific stakeholders. The combined insights of the program and case-study levels help produce a richer picture of the evolution of Connect, its achievements, limitations, and lessons of practical value for both Connect and other similar programs.

Figure 3 Ingredients of real-time evaluation of Connect at program and 'best-practice' venture level



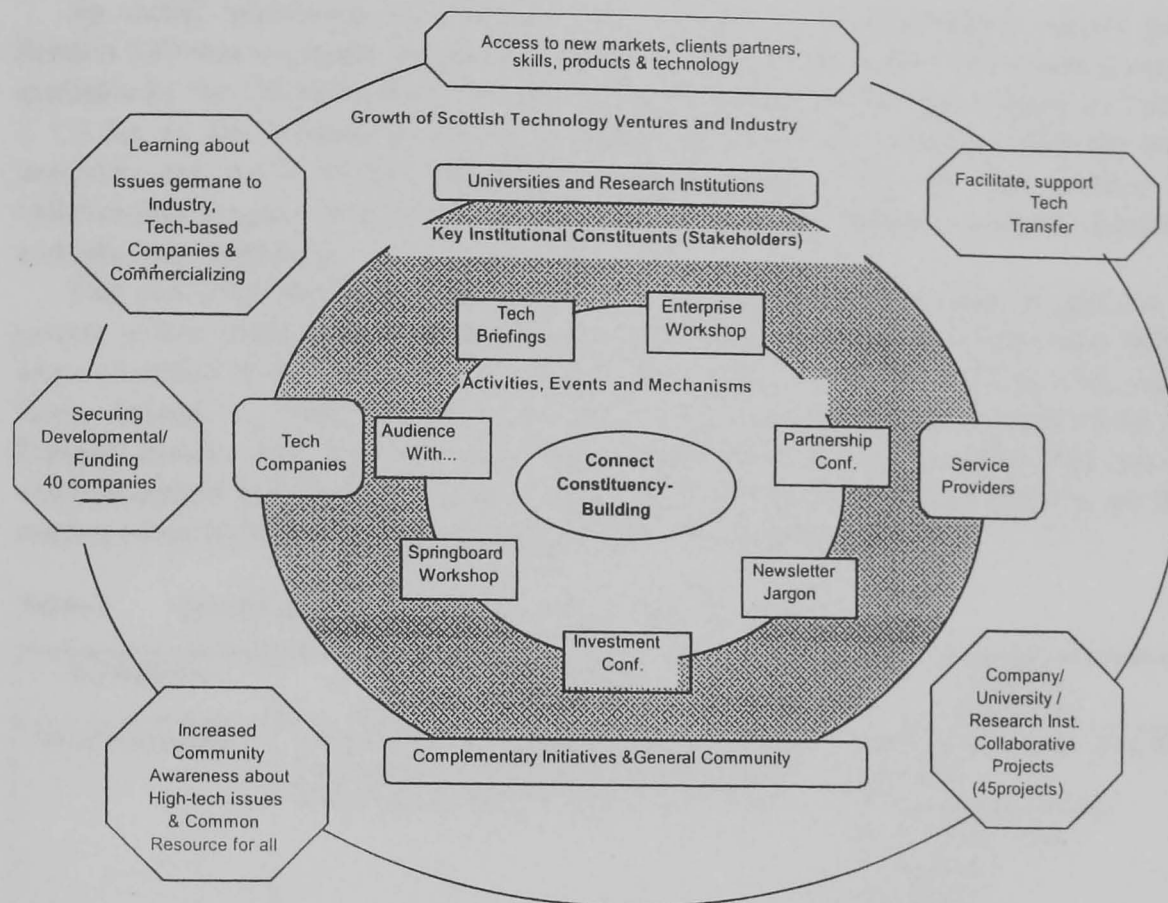
- A battery of research tools combining review of secondary literature and archival data, survey questionnaire, semi-structured interview guides, and elements of participant observation through event attendance.

6.1.1 The Conceptual Lens of Constituency-Building [34]

To provide a unifying conceptual lens to the understanding of the Connect program, the real-time evaluation methodology treats the development of Connect as a process of constituency-building targeted on specific audiences and intent on achieving defined targets through the implementation of an integrated set of mechanisms and activities. In particular, the lens of constituency building helps to partition and organise the treatment of the multiple elements involved in the development of the Connect constituency. The content of this constituency-building process is illustrated in Figure 4, in the form of a

multi-layered diagram containing Connect's events and mechanisms, Connect's existing and target stakeholders, and Connect's existing and target outcomes. These layers should not be seen as separate from each other. In practice, each of the outer layers subsumes and requires of the inner layers to happen.

Figure 4 Overview of Connect's constituency-building process



A more detailed explanation of Figure 4 shows that the circle at its centre represents the focus of the real-time evaluation, namely, the entire process of Connect constituency-building for the sake of supporting the creation, development and growth of technology-based enterprise throughout Scotland.

The first layer around the core shows the main activities, events and mechanisms through which the Connect constituency-process is realised.

The second layer around the core shows the key constituents or stakeholders, either present or targeted by the activities, events and mechanisms of the Connect programs.

The third and final layer around the core shows the target results expected to lead to the ultimate mission of growth of Scottish technology ventures and industry.

The critical feature of the Connect constituency-building process is its facilitation and encouragement of interactions between the stakeholders through their activities, events and mechanisms. The unifying lens of constituency-building should enable the capturing of this process.

6.1.2 Knowledge of Connect Program evolution and impact with reference to committed qualitative and quantitative targets

This aspect of the evaluation is a continuous, flexible and scaleable process that looks at the evolving Connect experience, identifying strengths, weaknesses, and lessons. Three reports under the title of *Connect's Targets, Evolution and Achievements* are envisaged during the two-year life of the evaluation.

An initial assessment of Connect's key indicators and quantifiable targets (see Section 5.6) was originally conducted by August 1999, on the basis of information made available by the Connect office. The results can be seen in the far right column of Table 3. Of the six key indicators, only two could be approximately quantified with the data available and some of the categories were not precisely defined. The number of collaborative projects, technology ventures securing funding, spinout companies formed, and jobs, was unknown.

This prompted the need to develop the methodology further in order to generate a picture with a much finer resolution of Connect's impact and value. Three value flows were identified from Connect's own objectives -social, knowledge and financial value flows. Indeed, as Table 4 shows, knowledge value is an overriding expectation of all Connect events, with financial value also pursued explicitly. At the same time, social value is central to Connect's mandate since informal and formal social contacts are the starting point for business-focused networks and developments.

Table 3 Quantifiable committed and realized targets for Connect

Key Indicators	Quantifiable Targets	Realised (Aug-1999)
No. of events held	-At least 162 events; minimum of 25 participants per event; target mix is 50% technology ventures; 30% academics and 20% business professionals	-109 events, 51 events under 25 participants 32% technology ventures 24% bus. professional 16% academic 24% "other" 4% individuals
No. of technology ventures participating in events	-At least 180 new and emerging technology companies will attend the mix of workshops and briefings; -Learning achieved will significantly enhance the ability of participating companies to increase their rate of sustainable growth -Quality target is 75% of participants to rate the event as "good" or better on a scale measuring the perceived value of the event to the business/individual	-this specific type of company was difficult to ascertain from avail. data. -Quality unknown
No. of collaborative projects	-At least 216 academics/research staff will attend the mix of events -At least 45 collaborative projects between technology ventures and university/research centres to be established in the project period	-over 400 staff -Unknown

Table 3 Quantifiable committed and realized targets for Connect (continued)

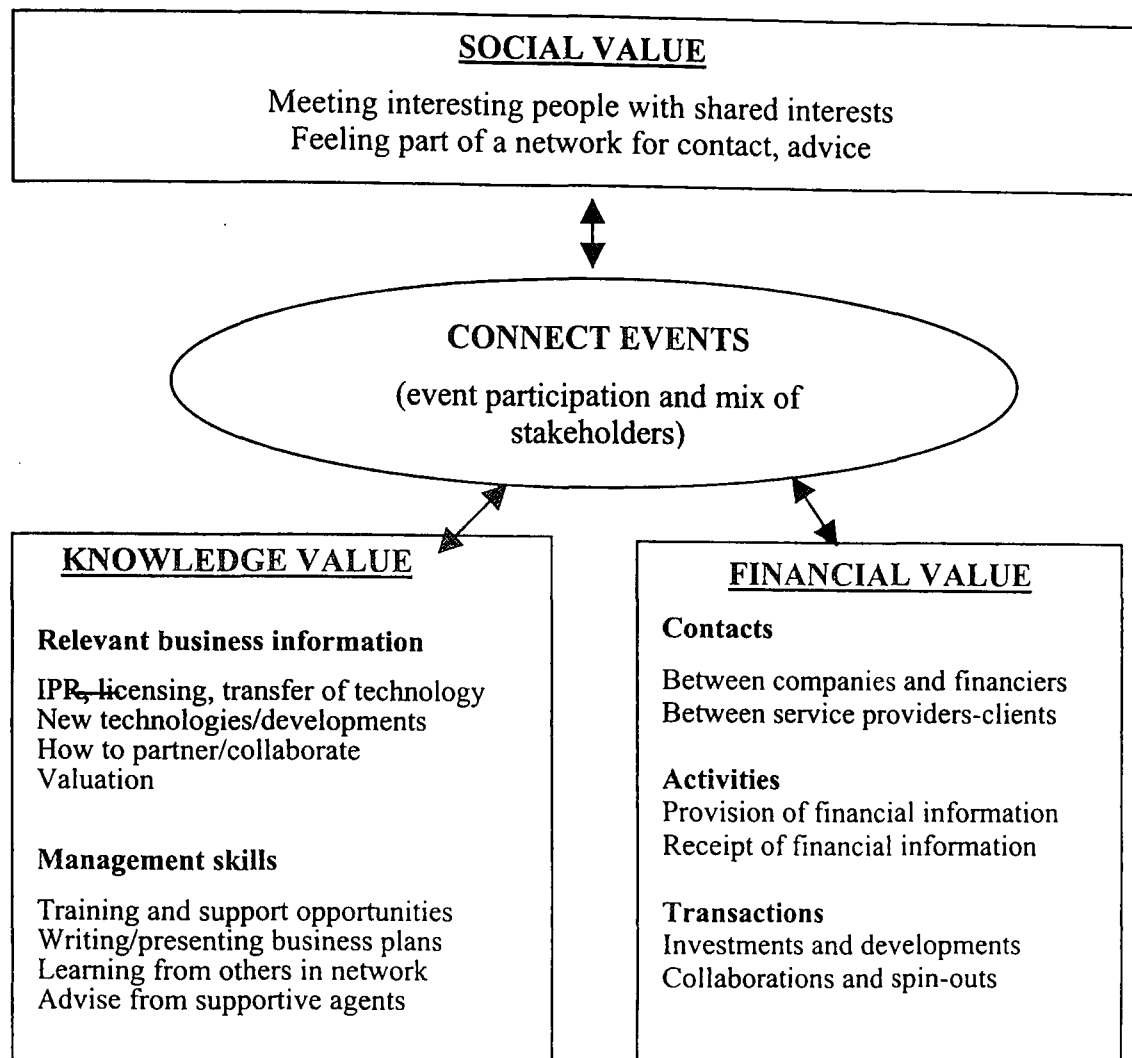
No. of technology ventures securing funding	-At least 40 technology companies will secure developmental/growth funding -Pilot has already established that technology ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance	Unknown
No. of spin-out companies formed	-Connect will facilitate and enable the creation of 15 spin-out companies from the Scottish science base and established technology companies -Participation in Connect is likely to improve the survival and growth rate of any spin-out company	Unknown
No. of jobs	-Minimum of 180 new high income jobs enabled by Connect	Unknown

Table 4 Value focus of Connect's core events

Type of event	Objective	Value focus
Technology briefings	To enhance understanding and facilitate technology transfer	Knowledge
Enterprise Workshops	To develop the general management skills of both technological entrepreneurs and entrepreneurial technologists	Knowledge
"An Audience with...."	Learning from the experience of others and discussing development of their own businesses	Knowledge
Springboard Workshops	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations	Knowledge
Investment Conference	To provide the opportunity for technology companies seeking finance to present to an international audience of investors.	Finance
Partnership Conference	To assist in the exploitation of the research through partnerships, joint ventures, new company creation	Knowledge/Finance

Each of the three value flows was then decomposed into topics aimed at capturing a gradation of impact or value added by Connect as perceived by the program's stakeholders. The resulting topics are listed in Figure 5 and provide the basis for questions to stakeholders on where Connect has been beneficial regarding social and business contacts, gaining or giving relevant knowledge, and attracting or providing financing for new companies or ventures.

Figure 5 Topics for determining social, knowledge and financial value from Connect events



Given the complexity and multiplicity of elements in the Connect constituency-building process illustrated in Figure 4, the evaluative analysis prioritises certain aspects of this process over others in different reports of the entire set making up the evaluation of Connect. This is facilitated by the longitudinal and process-oriented character of the methodology that permits a flexible and scalable application along the life of the project.

Thus, in dealing with the first layer of Connect's *activities, events and mechanisms*, the report chooses to focus primarily on what has happened regarding Connect's three core recurring events (see Section 5.5 above): *enterprise workshops, an audience with...*, and *technology briefings*), leaving the treatment of other Connect events and mechanisms for later evaluation. At least two elements of assessment are included:

- 1 *Actual effort versus committed targets*. This is a straightforward general quantifiable evaluation of the targets and milestones committed by the program (see Table 2).
- 2 *Response rates*. This is focused basically on event attendance. It is mostly quantitative and does not inquire into the quality of the responses.

However, in dealing with the second and third layers of Figure 4 -Connect's *institutional constituents/stakeholders and Growth of Scottish Technology Ventures and Industry*- the

6.1.3 Knowledge of 'Best-practice' cases at firm or venture level

As already noted, the real-time evaluation of Connect complements the findings at program level with 'best-practice' case studies seeking to reveal where and how Connect's value is realised through the experiences of specific stakeholders.

In practice, Connect participants are likely to vary in their appreciation and experience of the value delivered by the Connect program. Case study evaluation helps precisely to capture these individual differences or unique variations from one program experience to another. Case studies also help to reveal more deeply the actual impact (at a given point in time) of the Connect program relative to its ultimate economic growth objectives (third layer of Figure 4). These objectives may include, for instance, companies' growth factors influenced by Connect and estimated impact on growth (e.g., capitalisation, market share).

The cases selected for study may include spin-outs, project collaborations, business funding and development, technology transfer, etc. and will examine eventual success or failure to reach the ultimate objectives of Connect. The focus will be on selecting information-rich cases with the aim of capturing and describing the main issues, factors and type of value added by Connect to the development of the venture.

The combined insights of program and case study levels will help produce a richer picture of the evolution of the Connect constituency, its achievements, limitations, and lessons. This should prove of practical value not only for Connect but, also, for other network programs with similar characteristics to Connect.

6.1.4 Research tool-kit

The real-time evaluation methodology makes use of appropriate combinations of various research tools in order to gather the data and information necessary to generate the knowledge mapped out in previous sections at both program and case-study levels. This research tools combine review of secondary literature and archival data, survey questionnaire, semi-structured interview guides, and elements of participant observation through event attendance.

In particular, a combination of archival data, survey questionnaire and semi-structured interview guides is used to map the evolution of the Connect constituency and quantify its achievement against the committed targets.

Qualitative information on the programmatic development of Connect as well as detailed data and information for the in-depth case studies is gathered primarily by means of in-depth interviews guided by semi-structured guides.

In all instances, the research makes use of appropriate search and analysis of available archival material and secondary literature to support the analysis of the information coming from the interviews.

7 Summary of first-phase results of implementing the real-time evaluation of Connect Scotland

This section looks at the findings of the evaluation with particular focus on two aspects:

- 1 the fulfilment of Connect's committed target, and
- 2 the perceived value delivered by the program to its stakeholders

7.1 Program targets. Commitments vs. realisation

Table 5 provides the quantifiable targets for Connect's outputs and impacts for the entire duration of the national program until the end of year 1999.

Table 5 Quantifiable targets for Connect's outputs and impacts (up to end of year 1999)

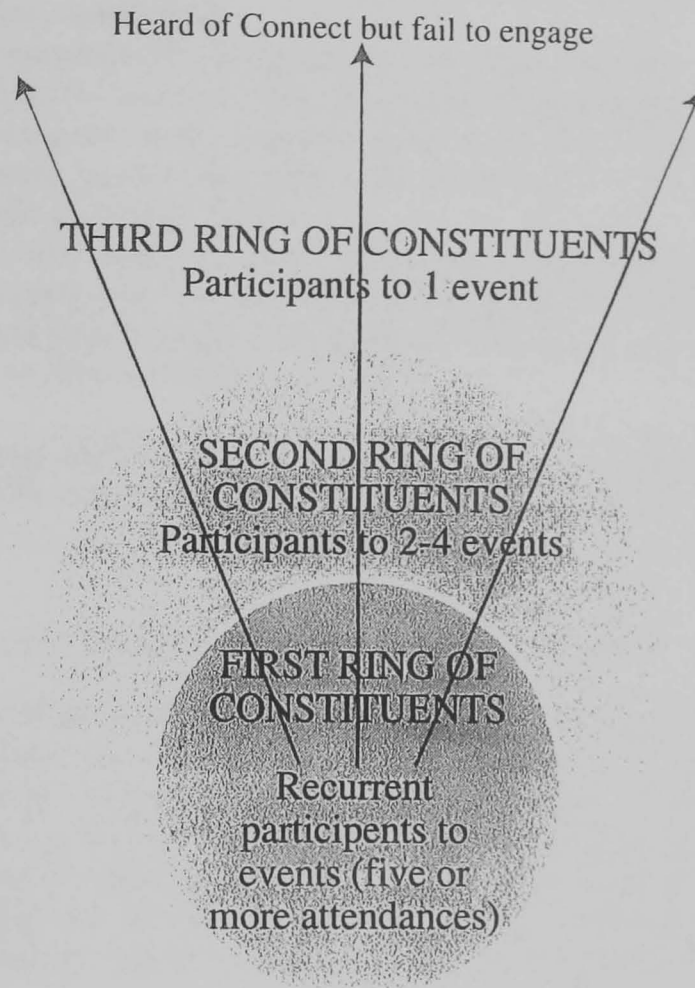
Key Indicators	Quantifiable Targets	Realised (at 01/2000)
No. of events held	-At least 162 events; minimum of 25 participants per event; target mix is 50% technology ventures; 30% academics and 20% business professionals	-over 162 events 62% tech ventures 14% academic (universities) 24% bus. Professionals (sponsors) 22 participants/recurrent event (average)
No. of technology ventures participating in events	-At least 180 new and emerging technology companies will attend the mix of workshops and briefings; -Learning achieved will significantly enhance the ability of participating companies to increase their rate of sustainable growth -Quality target is 75% of participants to rate the event as "good" or better on a scale measuring the perceived value of the event to the business/individual	-over 180 companies of all types (104 companies have become members by mid-2000) -Good to Very Good (84% of survey respondents)
No. of collaborative projects	-At least 216 academics/research staff will attend the mix of events -At least 45 collaborative projects between technology ventures and university/research centres to be established in the project period	-well over 216 (over 400 by August-1999) -Not identified
No. of technology ventures securing funding	-At least 40 tech. companies will secure development/growth funding -Pilot has established that tech. ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance	-Not identified.
No. of spin-out companies formed	-Connect will facilitate and enable the creation of 15 spin-out companies from the Scottish science base and established technology companies -Participation in Connect is likely to improve the survival and growth rate of any spin-out company	-Not identified
No. of jobs created	-Minimum of 180 new high income jobs enabled by Connect	-Not identified

7.1.1 Number of events held and quality

The real-time evaluation has shown that Connect is meeting its quantifiable targets for events. The committed cumulative number of events to be held by year-end 2000 (162)

report concentrates on the assessment of the social, knowledge and financial value delivered by the Connect program as judged by the stakeholders. Here the methodology adopts the 'expanded rings' approach illustrated in Figure 6, as a practical way to select a meaningful sample of specific stakeholders to be approached for the research.

Figure 6 'Expanded Rings' approach to assessment of Connect's value flows



The first ring includes those individual and institutional constituents/stakeholders who have participated most in the activities and events of Connect. These include stakeholders who are recurrent participants to Connect events (for instance, five or more events). Outward from the first ring there will be a gradation of participation passing through those stakeholders who, for instance, have attended two to four events, right through to those who have attended one event only, and to those who may have heard of Connect but not engaged with the program yet.

The premise is that those constituents in the first ring, by being more active, are likely to be the most informative about the value flows generated by the Connect program. The further away from the first ring, the less informative the stakeholders will be, although they may be highly revealing of reasons why the program has failed to engage them recurrently, or at all. The first-phase evaluation applied this 'expanded ring' approach to select a significant interview or survey sample containing stakeholders from the three rings illustrated in Figure 6.

will be significantly exceeded. This total includes all types of events that Connect delivers and not just the recurrent events that have provided the focus for this report. However, the target mix of participants (based on 1999 data of recurrent events only) is rather unbalanced, with higher-than-targeted percentages of service providers and technology ventures attendance and lower-than-targeted academic attendance. This suggests a potential difficulty regarding the objective of stimulating university spin-outs or university-industry collaboration.

The target of minimum 25 participants by event had a variable success: sometimes above, sometimes below the target. Thus, the number of participants per recurrent event in 1999 was 22, compared to the committed target of 25. This average attendance to all three recurrent events, however, increased in the second half of 1999 - most significantly in enterprise workshops (from 12 to 28).

Based on the value survey, Connect is achieving its event rating target. Eighty four percent of respondents rated Connect events from 'good' to 'very good' on average, compared to the quantifiable target: *Seventy five percent of participants to rate the event as good or better on perceived value.*

The existing rating of Connect events as 'good' or 'better' is too generic to be really useful. The value flows and comments on the events provide a more accurate assessment of event quality.

7.1.2 Number of technology ventures participating in events

Although the quantifiable committed target is 'At least 180 new and emerging technology companies will attend the mix of workshops and briefings', the criteria of 'new and emerging technology companies' was not precisely defined or distinguished in the attendance records, so that it was not possible to make a separation. If we take all companies however the target number of 180 is easily exceeded since, for instance, 163 companies attended one Connect event in 1999 alone and there are currently 104 technology companies as members, indicating that this target is being achieved.

7.1.3 Number of collaborative efforts and spinouts

Connect has a target of 45 collaborative efforts and 40 spinouts. This report has not uncovered direct evidence of spin-outs or collaborative efforts having being facilitated or enabled by Connect. This is perhaps one of the most difficult targets Connect set for itself, as witnessed by the findings in the review of literature [44] and, particularly, by the low level of university-business interactions revealed by this report. However, as the company case study reports 4 (Spektra Systems) and 5 (Yaba Ltd.) show [45,46], companies are benefiting from Connect, mostly in intangible ways that may have a connection to collaborative efforts, spin-outs and jobs. Spektra Systems, for instance, credited Connect as a mechanism they effectively used to get themselves well known in Scotland. In turn, Yaba Ltd. considers Connect the most important support program for their commercialisation efforts and they attend it regularly [47]. This could be seen as more in line with the softer comment accompanying the committed quantifiable target in Table 7, namely, the *Participation in Connect is likely to improve the survival and growth rate of any spinout company.*

7.1.4 Number of technology ventures securing funding

Connect has a target of 40 companies securing funding. The value survey did not uncover direct supporting reference to Connect having secured funding for technology ventures until end-1999. Some respondents saw some connection as a result of attending the events but did not ascertain direct causal relationship. This could be seen to be more in line with the softer comment accompanying the committed quantifiable target in Table 7, namely, *"technology ventures participating in Connect significantly improve their ability to secure development finance through their increased understanding of the needs of providers of finance."*

7.1.5 Number of jobs created

Connect has a target of a minimum of 180 new high-income jobs enabled by the program. Again, the value survey did not uncover direct supporting reference to Connect having enabled high-income jobs. This is consistent with the lack of evidence for direct Connect-facilitated spinouts or collaborative efforts already discussed.

7.1.6 Problem with the assessment of committed targets

There is a real problem with identifying, assessing and measuring Connect's direct impact on targets such as new venture development, company growth and job enablement. The problem is that the causal relations for this type of outcomes are not simple and, definitely, they are influenced by factors beyond the direct impact of the activities and mechanisms of the Connect constituency-building process. As an interviewee put it:

"Can Connect identify where the value conversations commence; where the 'sign-posts' are? Connect introduces people; what they do from there is beyond Connect, as Connect won't be involved, and the entrepreneur may not require anything else from Connect beyond the introduction".

(Scottish University Commercialisation Officer, interview, February 2000)

7.2 Stakeholders' perception of Connect's social, knowledge and financial value flows

As noted, the value survey decomposed each of the social, knowledge and financial value flows into 'value statements' aimed at capturing a gradation of impact or value added by Connect as perceived by the stakeholders. The following are the results, taking into account that the period goes until end of 1999.

Stakeholders rated social value as the most important perceived benefit from attendance to Connect events (Figure 7). This suggests that at the time of the evaluation the greatest impact of Connect has been on social networking. This is consistent with the logical evolution of networks where social interactions and acquaintances tend to precede the exchanges and collaborations involving knowledge and financial value. Indeed, Gregson [22] has stressed the importance of informal social contact that evolve into business-focused networks, and then into strategic networks. A test for the evolution of

the Connect program will be to increase the knowledge and financial value delivered by the program as perceived by the stakeholders.

Figure 7 Perceived value (%) from attendance to Connect events (n=69)

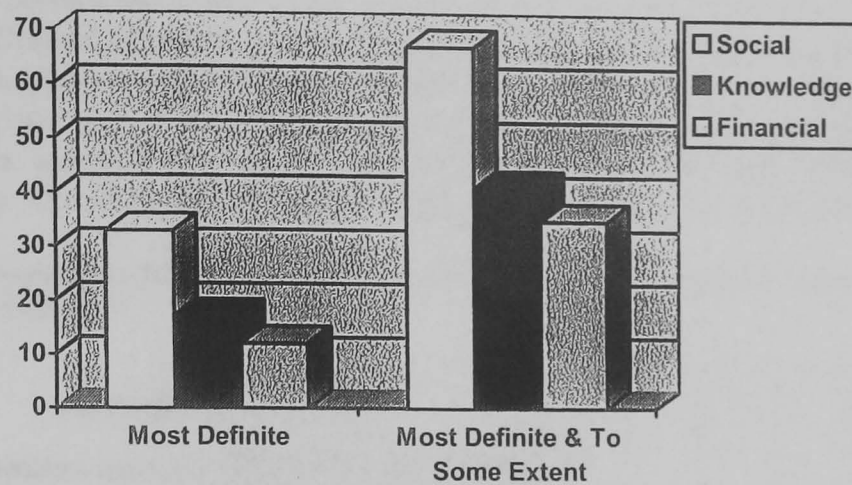
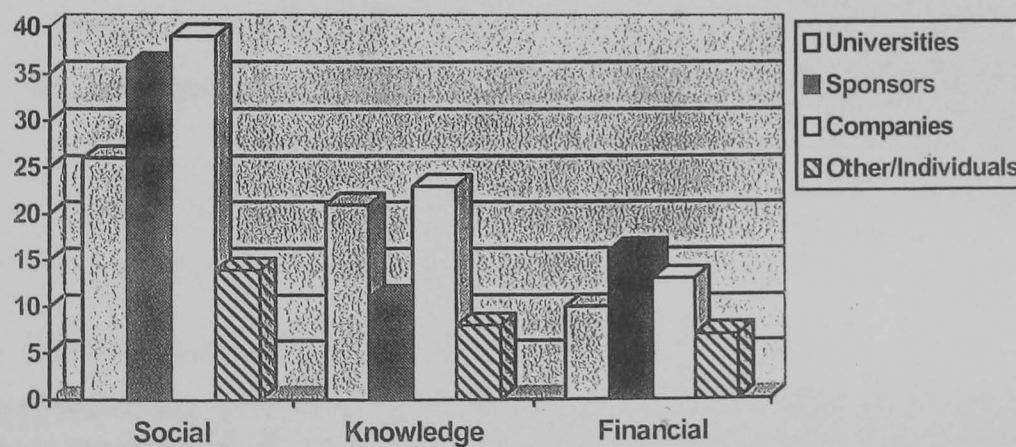


Figure 8 shows the variation in perceived social, knowledge and financial value of Connect by stakeholder category. Companies and sponsors vary the most in diversity of perceived value from Connect events.

Figure 8 Perceived value (%) by stakeholder group (n=69)



Let us now look in greater detail at each of the Connect's social, knowledge and financial values as perceived by each of the key categories of institutional stakeholders: sponsors, companies, universities.

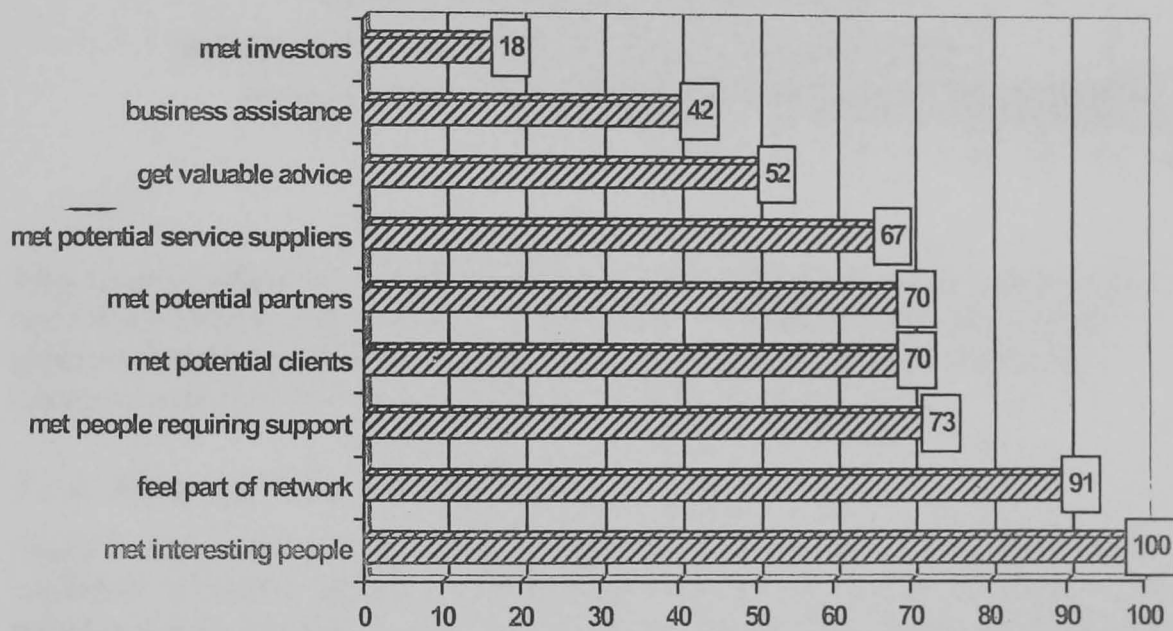
7.2.1 Social value for stakeholders

Figure 9 shows the ranking of 'social value statements' according to percentage of positive responses accumulated from all respondents. As expected the number of

respondents perceiving value decreases as the statements imply a more demanding value towards the top of the graph.

Thus 'value statements' directly related to network formation is seen by all respondents as the most valuable social value of Connect participation. Likewise, meeting interesting people that share similar interests and concerns, and a network of advice and contact are clearly important for all stakeholders. In particular, participants noted that Connect allows them to keep in touch with what is happening in Scotland, as well as providing a unique networking venue that allows individuals to begin the process of building up trust. In contrast, getting valuable advice or business assistance score much lower although still with a significant number of 42% and 52% respondents respectively. The ability to meet people willing to invest was scored the lowest.

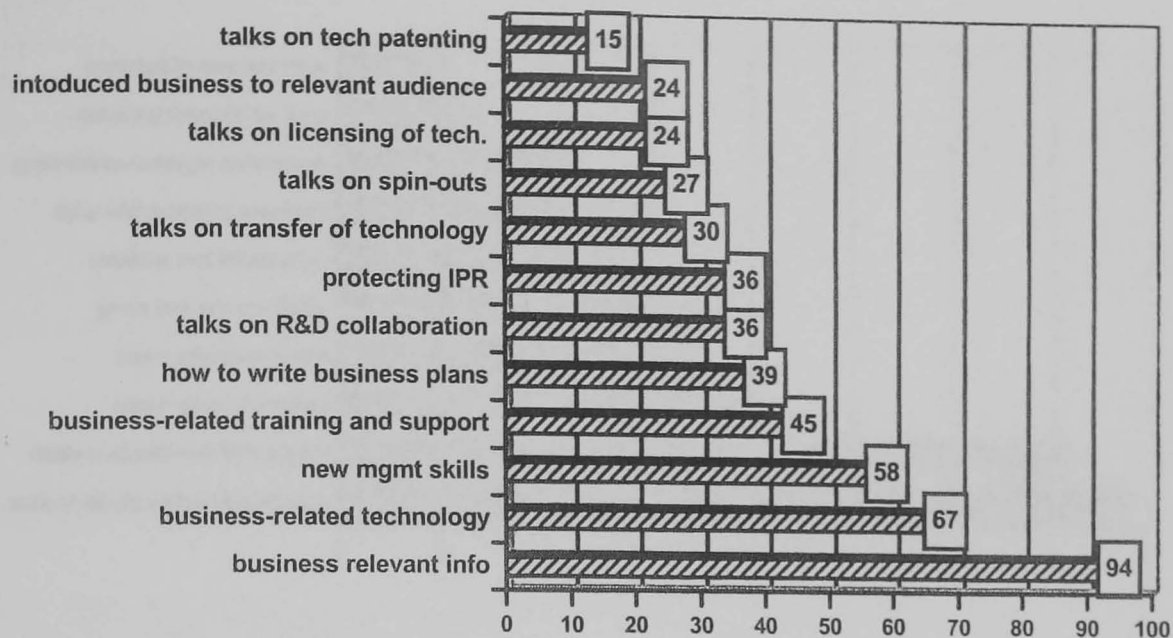
Figure 9 Percentage (%) of positive responses to questions relating to social value of Connect (n=69)



7.2.2 Knowledge value for stakeholders

Figure 10 shows that learning relevant information and relevant technologies for business was most important for all stakeholders. Again as expected, the number of respondents perceiving value decreases as the statements imply a more demanding value towards the top of the graph. Thus, knowledge interactions for commercialisation purposes (patenting, licensing, etc) were ranked low in perceived value. More specifically, during interviews, stakeholders identified lack of business-specific knowledge as a problem in Scotland, with Connect perceived as a facilitator of the 'lateral transfer of information'. Companies in particular saw significant value in hearing about other people's experiences in setting up businesses and the problems that they have encountered.

Figure 10 Percentage (%) of positive responses to questions relating to knowledge value of Connect (n=69)



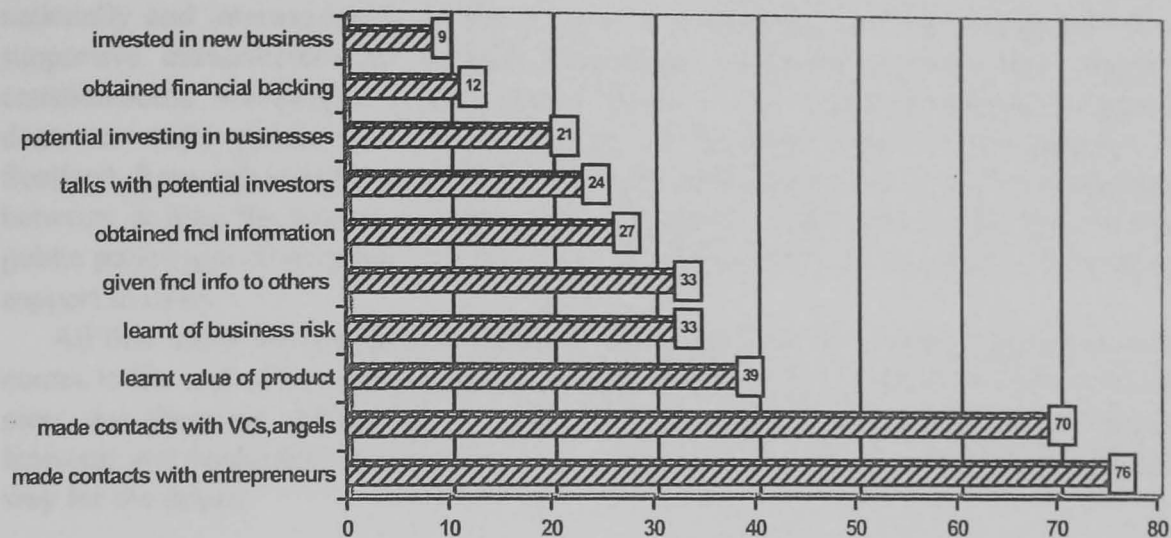
Also, Connect helped to increase “*market awareness, who are the players, angels, etc. and what is innovative in Scotland*”. Significantly, companies did not cite university-generated knowledge as highly important. This reinforces the point that university-business interactions still require substantial development work.

7.2.3 Financial Value for Stakeholders

Figure 11 shows that making contact with both entrepreneurs and business angels/venture capitalists is ranked highest, yet obtaining financial backing and investing in new business is ranked lowest. Again, as expected the number of respondents perceiving value decreases as the statements imply a more demanding value towards the top of the graph. This suggests that contacts for financial purposes are being made but effective investments have been below original expectations.

Universities and companies were the primary respondents to financial value questions on the survey, although service provider sponsors did indicate a desire for financial gain through service to new companies in the future. Interviews with commercialisation officers representing three universities found that seeking and securing financial support for university research was a prime motivation for participation in Connect. Showcasing and discussing commercially viable research is facilitated through Connect, yet other possible financial values in the survey were ranked much less in importance.

Figure 11 Percentage (%) of positive responses to questions relating to financial value of Connect (n=69)



Companies, on the other hand, reflect a variety of needs of which financing is one. There are a number of possible explanations for variations in perceived value by stakeholder category, amongst them

- Stage of commercialisation of company attending event(s). Adequate financial support and management skills are seen as critical elements in start-ups. Other elements may be more important later on or depending on the industry sector. For instance, those with a strong social and business network are most likely to be seeking more specific tangibles such as financing.
- Period of time the entrepreneur has attended Connect events. Those who have attended Connect events recurrently for a long period may find that value diminishes, particularly if the program does not refresh its content and activities and the predominant value-added becomes confined to social value.

8 The overall program evolution to date

There has been considerable growth in the size of the Connect constituency over four years (1996-2000), measured by the number of sponsors and members. Connect has clearly developed a comprehensive network of service providers and it is perceived as a unique event-focused forum in Scotland. However, feedback on the future of Connect mentioned both the need to develop stronger linkages with existing stakeholders, particularly universities and the need for more and wider linkages with other support agencies nationally and internationally.

Connect is perceived by a number of its stakeholders as a unique event-focused forum in Scotland. A number of stakeholders stated that Connect facilitates the building of 'connections' that no other agency at present can provide. However, some stakeholders

believe that it could be more. Thus, much of the feedback on the future of Connect both mentioned the need to develop stronger linkages with existing stakeholders, particularly universities, and the need for more and wider linkages with other support agencies nationally and internationally. In this respect, it is apparent that the development of a supportive infrastructure for Scottish technology companies involves other support constituencies. Assessing Connect's role in isolation from these other supportive agents does not really provide an accurate picture of this infrastructure's development in Scotland. Research is badly needed addressing the nature and value of, and inter-relations between, at least the key support programs in Scotland. This would help to advance the public policy aim of program integration and simplification for more effective delivery of support to users.

All this raises the question of future strategic direction for Connect, especially as it comes to the end of its current period. The role of Connect is a recurring issue, and it is clear that there are differences in stakeholder expectations. This will demand strong listening and leadership abilities to balance expectations and ideas in the best possible way for the future.

8.1 The issue of value for money

Connect has raised close to £1 million for a three-year period of activities until the end of May 2001. This amounts to an approximate average cost of £330K per year to finance all the activities, mechanisms and events. Connect has undoubtedly created a core constituency and it has been growing and delivering social, knowledge and financial value, and laying the foundations from which to climb towards the top end of the value flows. This should be seen in the perspective that the present evaluation cover mostly the first two years until the end of 1999. And as Director Ian MacDonald made clear:

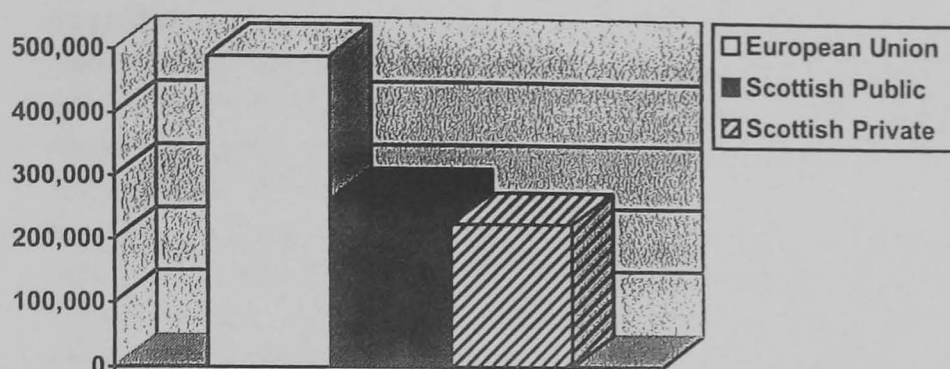
“... From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years.”

(Ian MacDonald, Director of Connect, 1997)

Nevertheless, the challenge remains for Connect to raise the delivery of value to the more demanding targets it sets for itself. These targets are not easy to achieve as testified by all evidence provided by the literature on support programs. They are also not easy to measure, particularly in the case of Connect, whose predominant role so far has been to ‘connect’.

A different angle of the ‘value for money’ issue can be seen from Figure 12. This shows that Scottish public sources, including universities, have contributed approximately £270K to the three-year Connect program (about £90K per year). Without counting the funds from university sponsorship (£118K), this amounts to close to £150K total or £50K per year.

Figure 12 Public and private sources of Connect funding (1997-2000)



This money has in turn leveraged over £220K from the private sector and close to £500K from European funding for Scotland. From this point of view of value for Scottish public money, Connect represents a rather inexpensive program for its achievements so far. The issue is whether these achievements can demonstrably be taken to the superior level of its own most demanding targets. In the spirit of the real-time evaluation, the following four recommendations were made to the Connect Scotland leadership in July 1999.

Connect should consider:

- 1 Improving its systems of tracking and monitoring stakeholders' participation in all its activities and assessing the quality and value of outcomes. More precise and detailed categorisations are required, for instance, the category of 'new and emerging technology companies' should be addressed in the light of recommendations that Connect should focus primarily on new and small companies. The evaluators have developed and used a system of 'value-flow analysis' that should become a periodic feature of Connect's monitoring for learning purposes.
- 2 Implementing further specific actions to enhance knowledge and value flows bridging universities and the business world relations. The evidence of the real-time evaluation is that the 'connecting' mechanisms implemented so far have still to realise their potential for fruitful interactions and new mechanisms may be considered. For instance, seeking to
 - increase the number of participant researchers by focusing on post-doctoral researchers who may be more liable to commercialise their technologies
 - communicate directly with researchers in order to avoid potential bottleneck generated by information "gatekeepers."
 - broker or offer mentoring service on the techniques and relevance of researchers' presentation for effective communication to business audiences
- 3 Developing stronger linkages with other support agencies nationally and internationally on the basis of a distinctive strategy.

- Nationally, the development of an integrated supportive infrastructure for Scottish technology companies involves other support constituencies and a closer dialogue and interaction will be beneficial. This may be catalysed by a research program addressing the nature and value of, and inter-relations between, at least the key support programs in Scotland. This would also help to advance the public policy aim of program integration and simplification for more effective delivery of support to users.
 - Internationally, there are a range of vibrant and emerging commercialisation networks in which Connect is already a player, i.e., European programs and the Connect Global Alliance. Enhancing and strengthening these relation for purposes of knowledge sharing and cross-fertilisation of learning experiences would be beneficial. This should help with the implementation of a systematic scanning for innovative and good-practice ideas for continuous refreshment of program's content and mechanisms.
- 3 Improving clarity and understanding of the governance of Connect by stakeholders and particularly sponsors. A more systematic communication and consultation effort will enhance the constituency-building process by helping to make Connect the 'property' of all members of the constituency. This greater inclusivity effort should include closer dialogue with strategic participants on ways of improving Connect processes and the sharing of real-time management accounts.

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*Building a National Network of Support for Academic Spin-outs and
Technology-based Companies in Scotland*

**Building a National Network of Support for
Academic Spin-outs and Technology-based
Companies in Scotland**

University of Edinburgh School of Management

G. Gregson

Introduction

Connect Scotland is a national support program to assist new technology companies, many of them created to exploit and commercialise university innovations. The Connect concept conforms to one of the key themes in the Scottish Higher Education Funding Council's (SHEFC)¹ 1995 Corporate Plan, namely, "to develop the responsiveness and vitality of the research base in Scottish higher education, and to work with higher education institutions and other agencies in contributing to economic competitiveness and the quality of life." More specifically it conforms to a critical objective within this theme, "to develop further links between Scottish higher education institutions and industry and commerce."²

A wide range of factors requiring attention to help nurture a technology ventures culture and economy in Scotland was identified in the SHEFC document that was built on the earlier Commercialisation Enquiry conducted by Scottish Enterprise (SE) and the Royal Society of Edinburgh (RSE). Strategies to tackle the problem were proposed, amongst them, the establishment of "a networking and business support infrastructure to generate effective academic-industry links facilitating the multi-directional flow of information between academia, companies and service providers. Connect at the University of California, San Diego, may be an

¹ MacDonald, I., *Connect – The University of Edinburgh Programme in Technology and Entrepreneurship*, 29 May 1996. Proposal to SHEFC detailing the Background, Mission Statement, Key Stakeholders, Programme Administration and Activities, Resource Requirements and Funding.

² Request for Funding from SHEFC to Support the National Development of the Connect Programme (1997)]

appropriate model.”³ The development of Connect in Scotland constitutes a clear answer to this recommendation and the “vision is to create and develop a programme that will have an impact in Scotland similar to that of the Connect programme in San Diego.”⁴

Description of Connect Scotland

Since its inception in 1996, Connect has maintained the following mission: To support the creation, development and growth of technology-based enterprise throughout Scotland”.

To a large extent Connect Scotland set for itself a fundamental challenge to stimulate a resource and expertise environment for interaction, learning and opportunities for different communities interested in the development of technology-based ventures and, ultimately, economic growth. Connect’s national focus requires that it bring together multiple actors in different regions of Scotland that include universities, sponsors, entrepreneurs and companies. Connect’s mission above follows the rationale that interaction between these communities is critical for the development of high

³ The document described UCSD Connect as follows: “Run from the University of California San Diego and funded by the private sector, it promotes the development of the region’s high tech industries and the commercialisation of the University’s research. It creates networking opportunities, stimulating the flow of ideas and knowledge between the academic, business and financial communities, and offers business development services assisting, for example, companies to obtain finance and academics to commercialise their research. Within the high tech community it acts as a hub, linking local and global networks.” (RSE/SE, *Technology Ventures: Commercialising Scotland’s Science and Technology*, Scottish Enterprise, Glasgow, 1996, p.22) The perception exists that similar conditions to San Diego would apply in Scotland, thus making possible the potentially successful implementation of a Connect programme in Scotland.

⁴ MacDonald and Ritchie, 31st October 1997, p.4.

growth and high technology enterprises. Bridging of the knowledge gap existing between these different communities is central to this purpose and relates to Connect's key objectives, as explained below.

Connect Program Objectives

1. Develop and educate an expert infrastructure that understands and supports the needs of technology-based ventures, giving companies access to networks of expertise and resources essential to their success in a global market-place.
2. Facilitate and support the transfer of technology from the Scottish science base to new and existing firms, either by spin-out or through collaborative projects.
3. Complement specific initiatives in individual agencies and organisations, providing a resource which can be used by all participants to promote and develop related activities and projects.⁵
4. Enhance the ability of new and existing firms to secure finance.
5. Educate entrepreneurs about business development and issues germane to their industries.
6. Help entrepreneurs to define new businesses and whether they should start them.

A unique feature of Connect is its independence, as it is primarily private sector driven, involving over 40 of Scotland's leading private institutions and companies. Connect itself became a private company in June 2001 after being based at the Edinburgh University

⁵ From the beginning Connect has made it clear that the aim is not to compete with established activity but to provide a channel for all participants, in

Management School since 1996. At the same time, Connect has broad support from the public sector, as all fourteen of Scotland's universities and the majority of local enterprise companies (LECs) that provide enterprise support throughout Scotland are Connect sponsors.

Connect staff includes CEO Ian MacDonald and Program Director Gillian Mayman, based in Edinburgh, Director Dr. Andrew McNair, based in Glasgow and Director Susan Morrison in Aberdeen. The Edinburgh office has two program assistants and a manager of the web-site (www.connectonthenet.com). Governance of Connect is provided by a board of directors that is elected by sponsors and company members.

Targeted Stakeholders and Their Potential Benefits

The Connect program targets the networking and involvement of all key stakeholders interested in the development of technology-based ventures and, ultimately, economic growth. In particular, benefits are expected to accrue to technology companies, universities and research institutions, private service providers, public complementary initiatives (support agencies) and the more general community. All these parties are envisaged to profit from the access to a common network of expertise, resources, and the opportunity to interact on a regular and informal basis through the Connect program of briefings, lectures, courses, technical and social support. In particular, the following potential benefits per stakeholder are identified:

particular research institutions and technology companies, to access skills, expertise, resources which already exist throughout Scotland.

Universities and Research Institutions

- Scottish science base will benefit from facilitation and support for technology transfer to new and existing firms, either by spin-out or through collaborative projects; this includes increased interaction between campus-based researchers and industry scientists;
- individual academics and researchers will benefit from an effective infrastructure which institutions can use to better understand the needs of technology-based companies and financial sectors and to commercialise their research.

Technology Companies⁶

Technology companies will benefit from an enhancement in their ability to:

- access new markets, clients, partners, products, technology and finance, and their general marketing skills; including access to one-to-one technical and managerial assistance;
- secure developmental/growth funding;
- stimulate collaborative projects between technology businesses and universities/research centres, including access to national and international sources of R&D funding and capitalisation;
- facilitate and enable the creation of spin-out companies from the Scottish science base and established technology companies;
- learn about business development and issues germane to their industries; and receive help to define new businesses and whether they should start them;

⁶ These are defined as companies competing on the basis of proprietary technology or know how.

Infrastructures for Academic Spin-off Companies

- In general, technology-based ventures and companies will benefit from the development of an expert infrastructure that understands and supports, and benefits from, the needs for success in the global market. The overall result is envisaged to lead to the creation of new, additional 'high income' jobs.

Service Providers (e.g., regional attorneys, bankers, accountants and marketing professionals)

- Service providers will benefit from enhanced competence regarding high technology products, companies and industries. This happens through the provision of technical briefings and education about unique characteristics of high-technology products, financing, manufacturing and marketing.

General Community and Complementary Initiatives

- The general community is expected to benefit from increased community awareness of the issues affecting the development of high technology enterprises, as well as from the provision of a community resource for data and information on the status of research activities and business development in the high-technology sectors;
- Complementary initiatives (support agencies and programs) will benefit from the provision of a resource that can be used by all participants.

Description of Connect's Activities

Connect's mission and objectives are to be achieved through a program of activities and events facilitating and encouraging interactions between the university sector, large corporations,

Building a National Network of Support for Academic Spin-outs and Technology-based Companies in Scotland

emerging companies, service providers, regional government, economic development agencies and support groups. The program brings together a wide variety of communities, including entrepreneurs, technologists, scientists, banks, equity capital providers, business consultants, accountants, lawyers and policy-makers, helping to bridge the knowledge gap existing between these communities. To achieve its aims Connect has designed an evolving program of 6 events (Table 1).

Type of Event	Description	Objective
Technology briefings	Forum for institutional researchers to present their work and research activities to Connect sponsors and tech companies.	To enhance understanding and facilitate technology transfer
Enterprise Workshops	Workshops bringing together technology companies and researchers with advisors and business professionals	To develop general mgmt. skills of both technological entrepreneurs and entrepreneurial technologists
Meet the Entrepreneur	Technology entrepreneurs discuss the development of their businesses, their successes and failures and their views of what it takes to succeed.	Learning from the experience of others and discussing development of their own businesses

Investment Conference	Annual venture capital investment conference.	To provide the opportunity for technology companies seeking finance to present to audience of international investors
Springboard	Forum for individual/businesses to present, in confidence, their technological concepts, proposed business strategy or business plans to an expert panel.	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations
Bootcamp	Two-day course focused on twenty to thirty companies, providing preparation for the investment conference.	To provide a series of experts to discuss core subjects; i.e. routes to market, refining the technology proposition.

Table 1: Connect’s Events

Each event in Table 1 is expected to play a specific purpose for specific target audiences and they all together combine to fulfil the targets of the overall program.

Recurrent Events

Three recurring types of events are central to Connect’s national constituency mandate: technology briefings, enterprise workshops and meet the entrepreneur events. This is because the majority of the Connect constituency (companies, universities and sponsors) come together at these three events. Through these events, Connect

aims precisely to stimulate a resource and expertise environment for interaction, learning and opportunities for different communities interested in the development of technology-based ventures and, ultimately, economic growth. As will be shown in the paragraph on the results of connection Programme, assessment of the development of the Connect constituency and the identification of stakeholders' value is derived from patterns of attendance to these 3 events (see par. Building A Supportive Constituency or Infrastructure, and Value Perceptions by Connect Stakeholders). These events are delivered primarily at four locations: Aberdeen, Dundee, Edinburgh and Glasgow.

Investment Events

Although many new companies are seeking different elements in their involvement with the Connect network, investment is seen as a critical element. Connect's investment conference continues to be unique in Scotland as a visible achievement. Attracting investors from Scotland, London, other countries of Europe and the US, the investment conference that began in 1997 is considered Connect's flagship event with 25 new and emerging technology companies now involved annually.

Connect now provides more direct support for technology companies to attract investment through two other events. To complement the investment conference, "springboard" is preparation for serious investment and a platform for the early stage spin-out type models, both from the private sector and from the university base. These technology propositions are show cased with the objective to generate internal leads that may be new executive money and/or

executive resources and advice, or in the case of most companies, early stage (SEED) funding. Connect intends on offering more than one springboard a year as the business environment develops in Scotland. This includes the expectation of successful student entrepreneurs from the Scottish Institute for Enterprise (SIE) with technology backgrounds that want to spin business out.

A third investment program, “bootcamp”, is similar to springboard as a preparation for the investment conference. Boot camp is a two-day course focused on twenty to thirty companies, providing a series of experts to discuss particular core subjects such as includes routes to market and refining the technology proposition. The focus of the 2001 bootcamp is on product marketing and how to sell the business to potential customers or partners or investors. Boot camp sits at the post-seed stage, up to raising serious venture capital funding, as it is a specific business issue that is being showcased.

This hands-on intervention by Connect includes a selection process whereby a panel of Connect sponsors choose companies they feel are best placed to stand as credible business propositions. Connect assists the chosen companies through to the preparation at springboard so that they are credible and confident in front of the audience and their message is focussed.

Results of Connect Programme

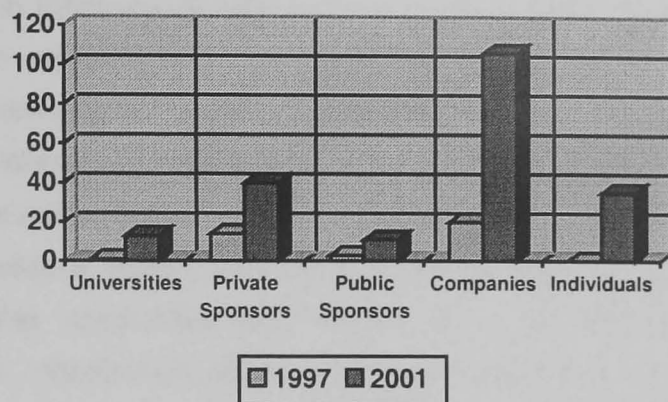
Results of the Connect programme are based on an assessment of its achievements in relation to its original objectives since 1997. One objective is to develop a national supportive infrastructure for new

technology-based companies in Scotland (par. Building A Supportive Constituency or Infrastructure). A second objective is to provide benefits to Connect's various stakeholders (as previously outlined par. Targeted Stakeholders and Potential Benefits). Paragraph "Value Perceptions by Connect Stakeholders" provides the results of two value surveys, the first conducted in 1999 and the second in 2001, that establishes how universities and technology companies in particular assess benefits derived from Connect and how this perception has evolved over time between the two surveys. This perception of value is related to attendance to the three recurrent events discussed in paragraph "Recurrent Events". A third objective relates to the benefits derived from investment activities of Connect (see par. Investment Events) that focuses on bringing investors together with entrepreneurs and new companies.

Building A Supportive Constituency or Infrastructure

Growth of Supportive Constituency

Graph 1 shows the growth of the supportive infrastructure, comprised of universities, private and public sponsors, companies and individuals from 1997 to June 2001. Overall, the size of the Connect constituency has grown to 169 organisations (63 sponsors and 106 member companies) and 35 individual members.



Graph 1: Stakeholder Growth over 5 Years (1997-June 2001)

The significant five-fold increase in ‘subscriber’ stakeholders of Connect since 1997 seems to suggest that the Connect program is delivering effective value to each category. This appears to be particularly the case as stakeholders have had to renew their subscriptions and most of them have done so. Sponsors contribute funding £3000 (€ 4860) fee for private companies per year. They are entitled to sit on the Advisory Board of Connect and are involved in the development of event topics for members. Members are companies and individuals paying a small fee of £100 (€ 162) per year in exchange for receipt of newsletter and the opportunity to present their ideas at the Springboard event and Investment Conference. The theme of Connect’s value to stakeholders will be dealt with in greater detail in paragraph “Value Perceptions by Connect Stakeholders”.

In assessing the growth of the constituency, it was found that a critical mass of both private and public sponsors was secured following two key milestones in Connect’s early evolution. The original challenge for Connect in 1996, according to CEO Ian MacDonald, was to get

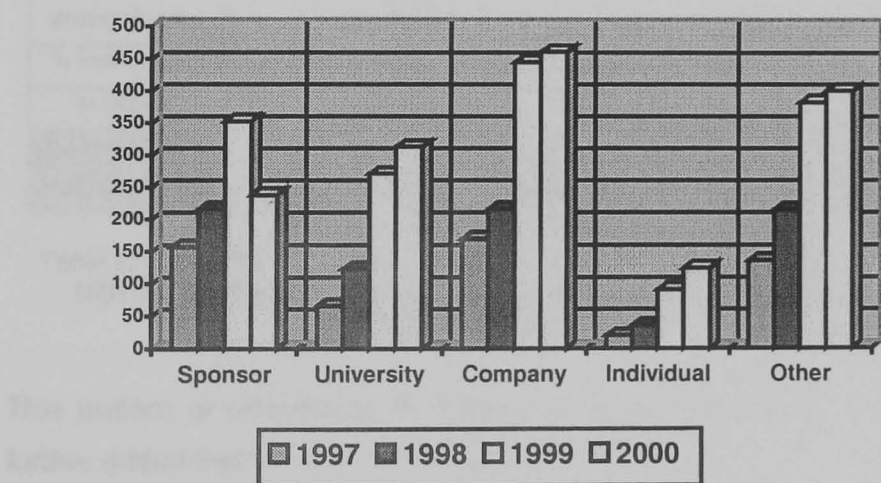
people in Edinburgh to sign up to a program based on the premise that “we are going to do something which is useful, will you pay for it”? Awareness of Connect as a program and brand was non-existent and initial credibility was provided by the addition of Martin Ritchie as Connect’s Chairman. One of Scotland’s most successful and visible entrepreneurs, Ritchie also provided Connect with management and leadership capabilities and access to a far-reaching business network. MacDonald affirms that Ritchie was key in establishing a core of 20 founding private sponsors and dealing with numerous public and private organisations to promote the concept of Connect.

Secondly, Scotland’s leading research-led universities (Edinburgh, Glasgow, Strathclyde and Heriott-Watt) signed up early as Connect sponsors, thus ‘pulling’ the other Scottish universities into the network quite quickly. It may be that other universities did not want to miss out on commercialisation activities and opportunities for their technologies, and the establishment of a Connect network with a base of Scotland’s top universities as public sponsors offered appeal to the remaining universities to join the network.

Although universities represent the largest single ‘homogenous’ category of sponsors, professional services (accounting, law and financial firms) comprise the majority of the private sector companies. There is a broad representation of sponsors from throughout Scotland, particularly from the public sector (universities and local enterprise companies). Not surprisingly, the private sponsors are primarily Edinburgh and Glasgow-based or along the central Scottish belt where the majority of businesses are located.

Mix of Stakeholders and Attendance at Connect Events

One of the key objectives for Connect is ensuring the ‘mix’ of stakeholders representing the universities, private and public supportive agents, entrepreneurs and technology companies. Graph 2 illustrates the evolution of stakeholder attendance (total numbers of people representing each group) to recurrent events between 1997 and 2000. It shows significant growth in all stakeholder attendance during this period, but growth was especially high for all stakeholder categories between 1998 and 1999. This reflects the fact that, during this time, Connect began developing the national constituency in Scotland.



Graph 2: Stakeholder Attendance to Recurrent Events, 1997-2000

Table 2 provides an overview of percentage participation by stakeholder against the quantitative targets originally set by Connect (green column) for their first 4 years. The ‘percentage of stakeholder’ targets were originally created by Connect CEO Ian MacDonald to ensure that there was an effective mix of stakeholders at core events. There is a difference between the target categories

(universities, technology companies and business professionals) with the categories used for attendance at the real events (sponsors, universities, technology companies, individuals and others). For comparative purposes, the discussion that follows equates “business professionals” with “sponsors” and “technology companies” is also assume to include “individuals” and “others”.

Category	4-Year Target	4-Year Achievement	2000	1999	1998	1997
% Universities	30%	16.25%	20%	18%	15%	12%
% Technology Companies	50%	29.25%	30%	29%	27%	31%
% Business professionals	20%	23.5% (sponsors)	15% (sponsors)	23% (sponsors)	27% (sponsors)	29% (spons)
% Individuals		5.25	9%	5%	4%	3%
% Others		25.75	26%	25%	27%	25%
% Companies, Indivs., Others		60.25%	65%	59%	58%	59%

Table 2: Connect’s 4-Year Quantitative Event Targets and Achievements 1997-2000. (Percentage of Attendees to Recurrent Events by Each Stakeholder Category)

This pattern of attendance in Table 2 is significant and it can be further added that:

- The attendance objective of the ‘Meet the Entrepreneur’ events is continuing to prove attractive to sponsors and companies, the primary intended target of the event. Universities and individuals attend the least, so this event has not developed into a platform for stimulating strong university-business relations.
- The attendance objectives of ‘technology briefings’ are not being fulfilled at present given that attendance by sponsors and companies is quite low. The objective of technology briefings is

to provide a forum for institutional researchers to present their work and research activities to Connect sponsors and technology companies. The attendance patterns suggest that there is much to be done to stimulate closer relations and interactions between university and business. The challenge for this event is to find ways to increase the mix of attending stakeholders. On the positive side, this event has almost tripled in growth between 1998 and 2000.

- The attendance objective of 'enterprise workshops' (to bring together technology companies and academic researchers with advisors and business professionals for the purpose of developing general management skills) is proving highly attractive to all stakeholders. Sponsors, companies and universities display the highest level of attendance.

Value Perceptions by Connect Stakeholders

Connect's development of a national support constituency, involving multiple stakeholder groups, universities, technology companies and sponsors, is expected to reflect in these groups different perspectives, expectations and motivations for involvement in Connect. Three value flows were identified from Connect's own event objectives -social, knowledge and financial value flows.

Type of Event	Objective	Value Focus
Technology briefings	To enhance understanding and facilitate technology transfer	Knowledge-social
Enterprise Workshops	To develop the general management skills of both technological entrepreneurs and entrepreneurial technologists	Knowledge-social
Meet the Entrepreneur	Learning from the experience of others and discussing development of their own businesses	Knowledge-social
Springboard and Bootcamp	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations	Finance-knowledge-Social
Investment Conference	To provide the opportunity for technology companies seeking finance to present to an international audience of investors.	Finance-knowledge-Social

Table 3: Value Focus of Connect's Recurrent Events

Table 3 shows that knowledge value is an overriding expectation of all Connect events, with financial value also pursued explicitly with the investment events. At the same time, social value is central to Connect's mandate since informal and formal social contacts are the starting point for business-focused networks and developments.

Each of the three value flows was decomposed into topics aimed at capturing a gradation of impact or value added by Connect as perceived by the program’s stakeholders. Resulting topics (Figure 1) provide the basis for questions to stakeholders on where Connect has been beneficial regarding social and business contacts, gaining or giving relevant knowledge and attracting or providing financing.

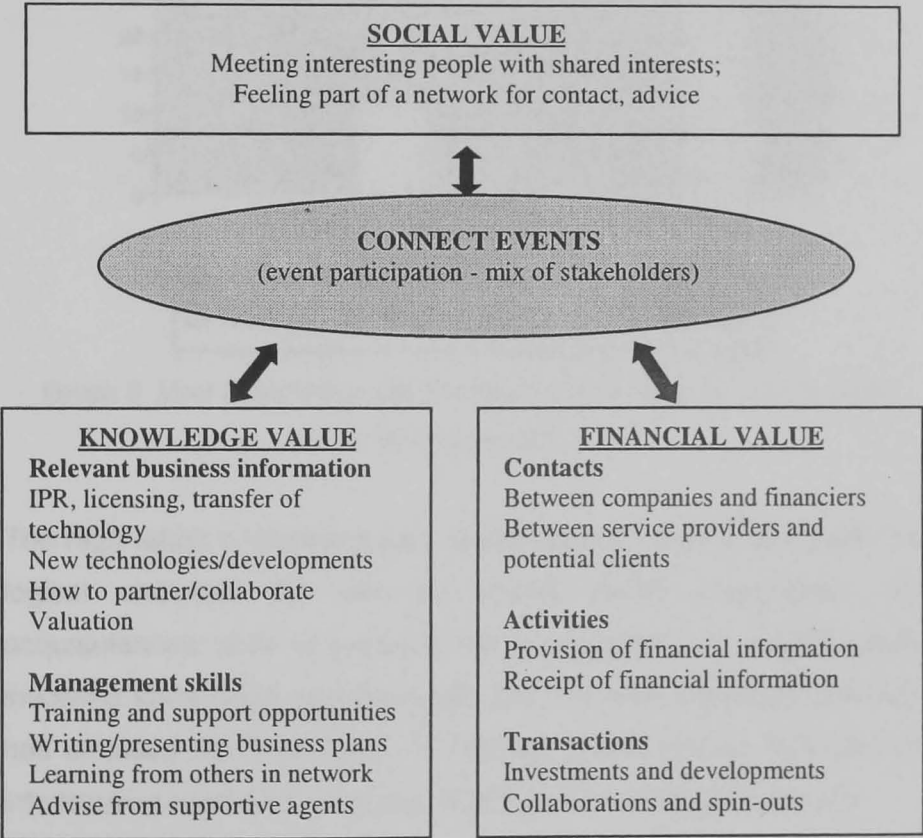
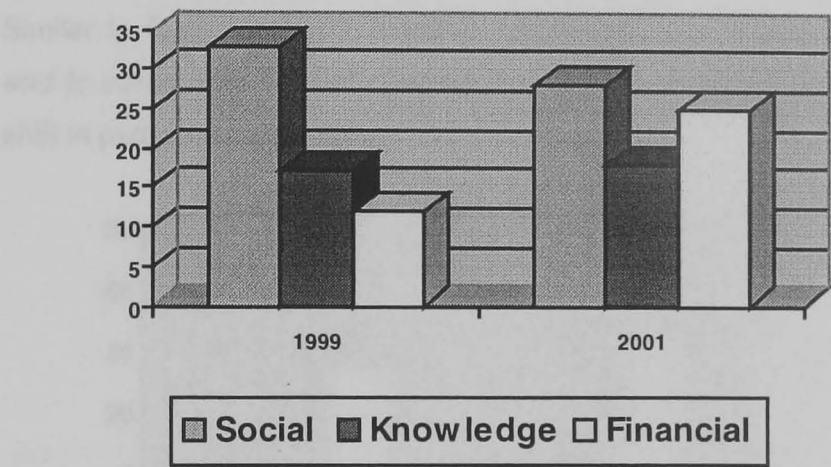


Figure 1: Social, Knowledge and Financial Value from Connect Events

Two value surveys were conducted, the first in 1999 and the second in 2001, that establishes how universities and technology companies

in particular assess the value of Connect and how this perception has evolved over time between the two surveys.

Graph 3 shows that, from both the 1999 (n=69) and 2001 (n=44) surveys, social value is rated as the most important perceived benefit from attendance to Connect events.



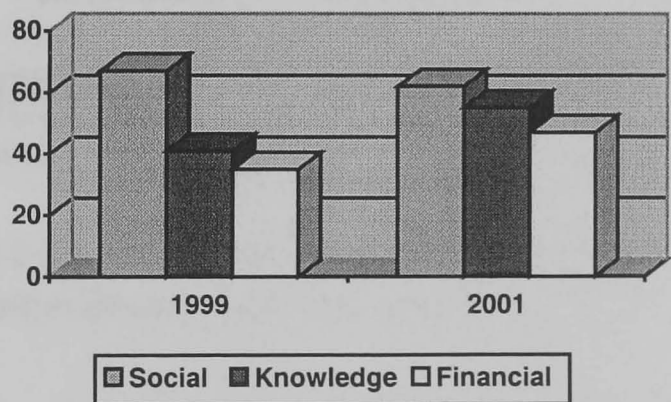
Graph 3: *Most Definite* Perceived Value (%) from Attendance to Connect Events (n=113)

The high rating of Connect as a social network is consistent with the logical evolution of networks where social interactions and acquaintances tend to precede the exchanges and collaborations involving knowledge and financial value. Indeed, literature research has stressed the importance of informal social contact that evolves into business-focused networks, and then into strategic networks.

However, Graph 3 shows an upward shift in *most definite* perceived financial and knowledge value, with a downward shift in perceived social value in comparing the 1999 and 2001 survey results. The difference in perceived value between social value and knowledge

and financial value has reduced significantly, suggesting that Connect is perceived as delivering more substantial knowledge and particularly financial value. Indeed, Graph 3 shows that financial value has overtaken knowledge value in the 'most definite' category. This is consistent with feedback from the Investment Conference, where a great deal of financial value was reported.

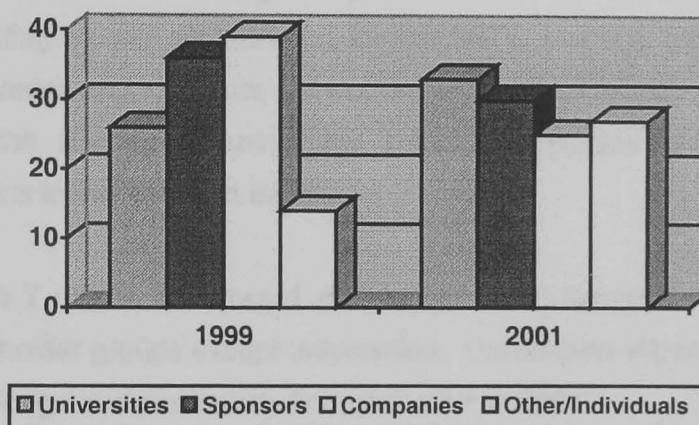
Similar to Graph 3, Graph 4 shows an upward shift in *most definite* and *to some extent* financial and knowledge value, with a downward shift in perceived social value.



Graph 4: *Most Definite and To Some Extent* Perceived Value (%) from Attendance to Connect Events (n=113)

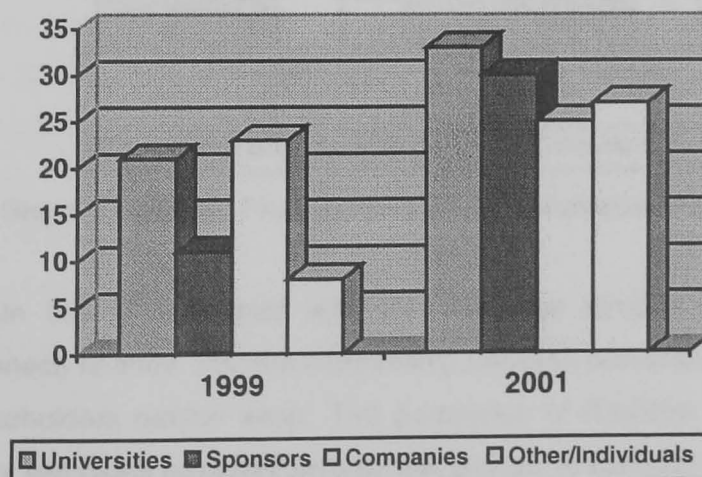
The results seen in Graphs 3 and 4 suggest that Connect's social network is evolving into knowledge and investment networks. It suggests that social networks have become more established and are perceived as less important. Established social ties provide the atmosphere of credibility, trust and shared that are considered prerequisites for knowledge sharing and development of business relationships that include investment. A better picture of this change is seen when perceived value is analysed according to stakeholder

categories. Graph 5 shows perceived social value has risen in university and individual categories and dropped in sponsor and company categories between 1999 and 2001.



Graph 5: Perceived Social Value (%) by Stakeholder Group (n=113)

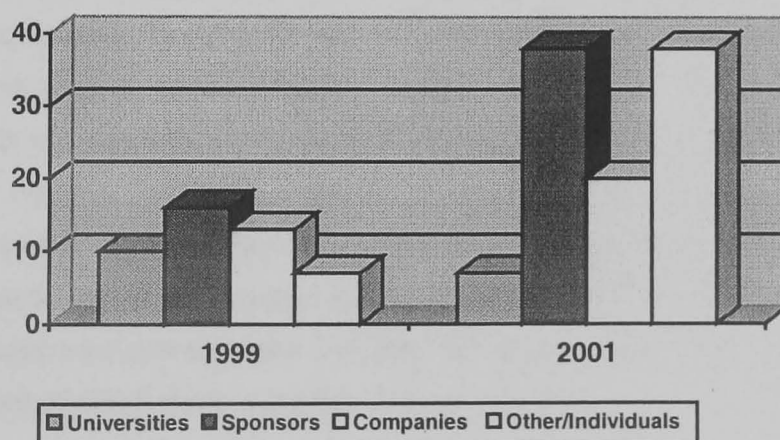
Graph 6 shows an upward shift in perceived knowledge value by all stakeholder groups between 1999 and 2001.



Graph 6: Perceived Knowledge Value (%) by Stakeholder Group (n=113)

The difference in perceived value between social value and knowledge and financial value has reduced significantly from the 1999 survey, indicating that Connect is perceived as delivering more substantial knowledge and particularly financial value. Financial value has overtaken knowledge value in the 'most definite' category. Providing as well as obtaining knowledge is a strong theme among companies and sponsors, but not universities, reinforcing the findings that the sharing of knowledge between university and business remains low at Connect events.

Graph 7 shows an upward shift in perceived financial value by all stakeholder groups except universities. Universities report the lowest knowledge and particularly financial value in 2001.



Graph 7: Perceived Financial Value (%) by Stakeholder Group (n=113)

Again this is consistent with the challenge already identified for Connect, namely, that the relationship between universities and other stakeholders remain weak. The perception of financial value shows clear variations between stakeholder groups, in contrast to social and knowledge value perceptions. Individuals outperform sponsors and

companies regarding the response to 'obtaining investment'. It may be that business angels are playing a strong role in investments stimulated by Connect. As well, a number of individual members represent financial intermediaries.

University Perceptions of Connect's Value

University respondents in general assessed the social value of Connect as an informal introduction to key supporters of high technology in Scotland. One respondent noted that *"networking is the start of everything, that includes the build-up of friendship and trust"*, echoing the importance that other stakeholders place on creating social relations for new participants initially upon entering the network. Another feedback focus from university respondents was the access to an informed network. Three universities alluded to their need to keep in touch with what is happening in Scotland; *"[our] university needs to be there"*. Another respondent added that Connect is a valuable resource, in that *"[one] knows Connect is there if you need it, as it is a group of people within a supportive environment"*. It is apparent that Connect is both a venue and vehicle for universities, as most university respondents have an expectation that social contacts can and will lead to collaboration. This is an important qualifier of the university view of Connect.

University respondents commented on the importance of information on commercialisation issues, i.e. to gain insight into how others are tackling issues of commercialisation; such as where are the gaps?

- *"Connect assists in the process of making the decision of doing something alone or within the university."*
- *"Connect facilitates a greater awareness of closed institutions."*

- With Technology Briefings, one can *“get a snap-shot of a technology or industry sector in a single session”*.
- Another respondent stated that *“knowledge through events is realised on how to do something; this differs from experience with the civil servant mentality”*.

Universities are unanimous in stating their expectation to secure financing through Connect events. Financial value is the most important reason for attending Connect. Universities are seeking investors for their technologies. Interviews with commercialisation officers representing three universities found that seeking and securing financial support for university research was a prime motivation for participation in Connect.

- *“[Our] university already has technologies waiting to go.”*
- *“Through Connect we hope to expose enough to secure financial backing for university technologies.”*
- *“We want to meet potential funders of our technologies.”*

Showcasing and discussing commercially viable research is facilitated through Connect, yet other possible financial values in the value survey were ranked much less in importance. Three commercialisation officers stated that they had yet to “obtain financial backing for ideas/products” but expect to in the future. A fourth respondent on this question checked “not at all”. This is further evidence of the still un-bridged gap between university and business and it is bound to show in the number of spin-outs, collaborations or other targets reflecting the strength of this relationship.

In summary, university recommendations for Connect included:

- Increase the number of researchers at Connect events, focusing on post-doctoral researchers who may be more liable to commercialise their technologies.
- Communicate with researchers directly to avoid potential bottleneck generated by information “gatekeepers”.
- Program topics of special interest to universities include a “showcase” for new start-ups at the universities.... a baby version of investment conference, and sessions on product marketing by sector, branding, company law and human resources issues.

***Entrepreneur and Technology Company Perceptions of
Connect's Value***

Entrepreneurs and technology company respondents were more diverse in their perceived social value in attending Connect events. One common theme is the importance of Connect as a venue for initiating and developing social relationships that may lead to business relationships through Connect events. The following quotes are important qualifiers of this expectation:

- *“Networking is most important for first-time attendees to build relationships; then for keeping in touch and keeping those contacts.”*
- *“Connect facilitates making and keeping contact in a range of sectors, i.e. academic and public sectors, various industry sectors.”*

Connect is also seen as a venue for actually doing business, due in part to the informal atmosphere that allows for interaction of service providers and companies that are potential clients. Connect's recurrent events provide a social environment that is conducive for business.

- *“Connect is well-suited for doing business and facilitates it well; there is no problem flashing business cards at the events; Connects is good at managing these different interests.”*
- *“The networking platform is very important in that it provides a solid mechanism for the biotechnology community to network with other stakeholders.”*

A third social value expressed from entrepreneurs and company respondents was the importance of Connect as a venue for like-minded entrepreneurs experiencing similar issues and difficulties.

- *“Connect reflects a shared vision of everyone of future success of start-ups.”*
- *“It is a place to meet different people that share similar experiences...it's lonely as an entrepreneur.”*

Knowledge value for companies was most important through shared business experiences with other entrepreneurs. Company respondents noted the value of hearing about other people's experiences in setting up businesses and the problems they have encountered. Connect is seen to also provide a cross-sectoral venue and relevant topics according to industry sector.

Comments related to the learning process being facilitated through Connect, through an evolutionary process that involves different issues raised and discussed at events. A number of company respondents were interested in information on services, such as information on important business services (e.g. *“last year's seminar on insuring businesses was informative”*). It is interesting to note that companies do not cite university-generated knowledge as highly important. This reinforces the point made earlier that university-business interactions still require substantial development work.

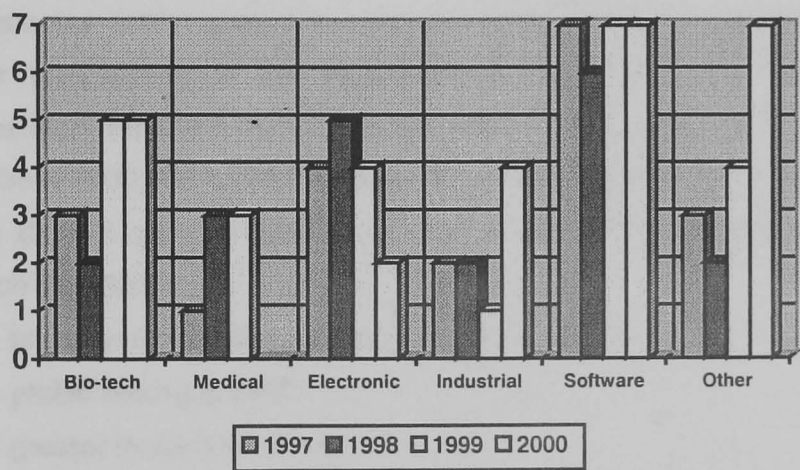
Both new companies and service providers indicated their expectation of finding investors and investment prospects respectively. Introductions by third parties was noted as an important aspect of establishing contacts with investors at events and being introduced to new business prospects. A number of comments alluded to the quality of the investment conference. Recommendations included that it should be held every 6 months instead of annually because of the frequency of start-ups. One of the respondents noted that this gives a reason for foreign investors to come to Scotland. In summary, company recommendations for Connect included:

- *Monitoring and assessment of the company 'flow-through' will provide valuable information on understanding where Connect's value begins and ends.*
- *Connects should be aware of seeking continuous refreshment of ideas for program's content and mechanisms.*
- *Other supportive agents should be identified that can be recommended as companies reach the peak of their Connect 'value curve'*
- *Should Connect establish various levels of supportive agents that facilitate start-ups as well as growth of technology companies, or maintain its focus on emerging technology companies?*

Value through Investment Events

Connect has run 4 consecutive Investment Conferences from 1997-2000. Together these conferences have enabled a total of 89 Scottish companies, the majority of these university spin-outs, to present to investors.

Graph 8 shows the breakdown of sectors for companies represented during each of the conferences. It can be seen that the 'software' companies have been consistently the most prominent sector in the four Connect investment conferences, although e-commerce (inside *Other*) reveals dramatic growth between the 1999 and 2000 conferences. This reflects the high level of dot-com start-up activity in 2000. Biotechnology has also had a consistent presence in the 1999 and 2000 conferences.



Graph 8: Connect Investment Conference Companies by Sector, 1997-2000 (the *other* category (far right) is primarily e-commerce)

The number of sectors represented at each of the 4 conferences provides evidence of the heterogeneous nature of new companies seeking funding in Scotland. With a limited investor base in Scotland, it can be argued that bringing together these companies and investors to a single event provides efficiencies in scale and centralises a critical mass of investors to focus on a critical mass of companies to make it worthwhile for both groups.

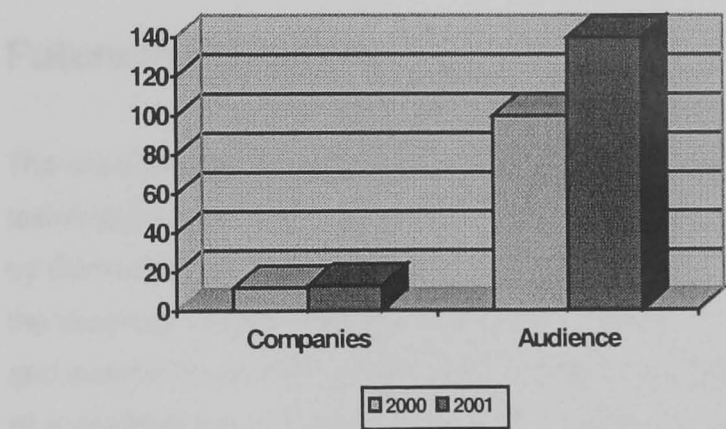
In order to determine the level of investment generated from the investment conference, 65 companies that presented at 1998, 1999 and 2000 Investment Conferences were contacted by both e-mail and phone. Two questions pertaining to investment were asked: (1) did you directly or indirectly gain investment through your participation in the Connect Investment Conference? And (2) is there a level of investment (% sought or £) attributable to your participation in the Conference?

A total of 20 companies responded. Results reveal that 8 out of 20 companies (40%) gained investment, directly or indirectly, through their participation in the Investment Conference. The level of investment ranged from 10% to 50% of original amount sought and (£) from £100,000 to £1.5 million. In addition, of the 12 companies that did not gain investment, 9 companies cited intangible gains, which included:

- better understanding of the investment process
- profile raising and PR
- greater focus on business planning
- process as an invaluable pre-cursor to subsequent funding

It is evident that the Investment Conference has produced benefits to a significant number of companies that have been able to present their business case at it. Not surprisingly this event has become widely appealing to both companies and the financial community, with an increasing number of international financial participants.

In addition to the Investment Conference, Connect has run two Springboard events in 2000 and 2001 (Graph 9). Springboard 2000 had 12 companies and 100 audience attendees while Springboard 2001 grew to 13 companies and 140 attendees. Audience attendees include Cisco Systems, BP, 3Com, Scientific Generics and 3i, among others.



Graph 9: Springboard Companies and Audience, 2000-01

The intention of Springboard is to assist companies to become investor-ready, and involves Connect working with each company. Connect found that early stage companies presenting at the Investment Conference had developed to the point that these same companies came back looking for second round funding or pre-IPO funding. Thus in 2000, after 3 Investment Conferences, the Springboard Workshop was created to specifically focus on companies seeking early-stage financing.

Connect is expecting to increase the frequency of Springboard events as a result of the success of both the Investment conferences and Springboard. Another factor in expanding these events is Connect's

involvement with the Scottish Institute for Enterprise (SIE), part of a UK-wide initiative focused on creating a more positive environment for entrepreneurship from university undergraduates and graduates. It is expected that a growing number of Scottish university students wanting to create their own businesses will use Connect events such as Springboard.

Future Perspectives

The creation and evolution of a national network of support for new technology companies and academic spin-outs has been championed by Connect since 1996 and has coincided with significant changes in the business climate and technology sectors in Scotland. Enthusiasm and support for technology throughout Scotland has grown as a result of a combination of factors: successful companies and investments, greater knowledge of the technology sector and an extensive support network. The evidence is quite clear that knowledge of the technology sector throughout Scotland and the profile raising of the entire technology sector has been advanced through Connect. Understanding how technology companies are created and issues of commercialisation and development and growth have been identified in the value surveys.

The cyclical nature of the technology sector has not diminished sponsorship support for Connect based on the high level of membership renewals by existing sponsors. Connect's founding sponsors provided optimistic visions of the future of the technology sector back in 1996/97 that justified the decision by many to become

involved in Connect, according to Program Director Gillian Mayman. At the same time, many people in Scotland also did not understand the technology sector and it was this concern with not having a grasp of the industry that drew people to the Connect network. Connect CEO Ian MacDonald also sees the longer-term approach to expectations of the sector as an indication of the growing maturity of the technology sector and its support in Scotland.

With success has come a greater cultural acceptance of the entrepreneur as a legitimate occupation in Scotland, according to Gillian Mayman. Successful entrepreneurs, with their experiences and lessons, now provide knowledge, social contacts and investment to new entrepreneurs and companies. The entrepreneurial culture has changed particularly at the source of technology innovations, the Scottish universities, according to Mayman. She suggests that the traditional academic focus on the technologies themselves has evolved to the commercial applications of these technologies. A number of reasons may explain this change. Successful companies and wealth accumulation have provided role models for other academics and researchers. Academics have a greater awareness of what is required to commercialise their innovations. And the role of technology transfer departments has given a greater awareness to the push toward applying and commercialising university innovations and research.

However, Dr. McNair, Connect Director, cautions that there is still much more effort needed to link the university environment with the commercial one in supporting spin-outs and new technology companies. One difficulty is trying to persuade academic institutions of the value of the technology-focused network of Connect. McNair

points out that some of the universities are very good at working with Connect but the larger universities tend to display a high degree of ownership. Glasgow and Edinburgh, for example, have a large staff in their technology transfer departments. These departments and organisations have various company development teams and technology teams that are responsible for commercialisation activities focused on maximising the university's returns from its innovations. The issues of ownership of projects and research aside, Connect is focused on trying to get academics in touch with independent expert advice and resources so that they may access a whole array of information that they can use and gain knowledge from.

The problem of attribution remains in identifying, assessing and measuring Connect's direct impact on technology companies. A key factor is that the causal relations for these types of outcomes are influenced by factors beyond the direct impact of the activities and mechanisms of the Connect constituency-building process. A Scottish University Commercialisation Officer, in the 1999 survey interview, stated, *"...can Connect identify where the value conversations commence; where the 'sign-posts' are? Connect introduces people; what they do from there is beyond Connect, as Connect won't be involved, and the entrepreneur may not require anything else from Connect beyond the introduction"*

As well, important economic factors influence the creation and growth of technology companies. Research cites the importance of sectoral conditions, as well as expected profitability and the presence of entry barriers. External supply and demand factors are shown to be a key influence on new company formation. Indeed, the impact of public policy is an unresolved issue as it relates to new company formation,

and includes such factors as taxes and cost of living. Individual traits, motivations and skills of the entrepreneurs involved in the companies are also key factors.

Other supportive agents also exist in Scotland that influence the growth and development of technology companies. Local enterprise companies (LECs) supported through Scottish Enterprise offer services to new companies and local entrepreneurial networks and technology and sector-specific associations are also available. As mentioned earlier, the Scottish Institute for Enterprise (SIE) is focused on leading the next generation of entrepreneurs from Scotland's leading research universities and Connect and SIE are working closely to provide entrepreneurial content and support initiatives for these students.

A key distinguishing feature of Connect remains its focus on developing a private-public national support network while providing an important first port-of-call for young Scottish technology companies and academic spin-outs. According to Dr. McNair, Connect's achievements should be considered in the context of cultural and social change in Scotland that he suggests is a slow process or a 'drip effect' when attempting to change the status quo that includes a low entrepreneurial culture. However, it is evident that Connect needs to be bullish of successes to date. Indeed, Connect Scotland's model is now being emulated by other regions in the UK with the emergence of Connect Midlands and Connect Yorkshire in 2001.

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***Building a National Network of Private - Public Support for High
Technology Start-ups in Scotland***

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Abstract

This paper examines the evolution of *Connect Scotland*, a national network of private-public stakeholders that supports high technology start-ups and promotes regional entrepreneurship. The paper establishes why and how private-public sponsors collaborate with entrepreneurs and technology companies, the levels of interaction and multi-stakeholder benefits generated within the network and how this value may be evolving over time. Findings show key milestones in building the national network that include strong evidence of need for intervention and support, establishing early private-sector program credibility by involving a high profile business leader and early public sector program credibility with support from Scottish Enterprise and Scotland's leading research universities. The identification of clear benefits to be derived by stakeholders of the network and a formal, integrated set of events and activities bringing together stakeholders and facilitating exchange have also contributed to building a national network. Results from interviews with stakeholders and two value surveys, in 1999 and 2001, provide evidence that private-public sponsors and company members join Connect and renew their paid sponsorships and memberships based on specific benefits they anticipate and realise through network participation. Social, knowledge, and financial value was found to change over time, with knowledge and financial value becoming more important as social interactions are developed among active network participants. Findings also suggest that further effort is needed to improve the exchange between university commercialisation stakeholders and others within the network. The paper concludes that Connect's success to date in creating a national enterprise support network can be attributed to a combination of multi-stakeholder benefits being realised and Connect's integrated network building events and network management activities.

1.0 Introduction

This paper focuses on a regional enterprise support network in the United Kingdom – *Connect Scotland*. Since 1996, Connect Scotland has provided a formal approach to facilitating collaboration of support agents to assist technology-based start-up companies and academic spin-outs. Connect is similar to other support programs that attempt to emulate certain characteristics found in successful technology regions such as Silicon Valley (Saxenian 1990, 1994). This includes the concept of the ‘entrepreneurial infrastructure’ (Vaughn, 1983; Porter, 1990) that describes the facilities and services present within a given geographical region which encourage the birth and development of new enterprises. Within this theme, new enterprise creation will be affected by local factors that include access to capital, specialised inputs, proximity to customers, specialised labor and psycho-social support, among others (Porter 1998; Cooper and Folta 2000).

What distinguishes Connect from many other regional support initiatives is that it is primarily *private-sector driven*, with over 50 of Scotland’s leading companies, many of these professional service providers, acting as sponsors. In addition, all fourteen of Scotland’s universities and Scottish Enterprise, the government agency providing business support throughout Scotland, are public sector sponsors. This private-public mix of sponsors combines with over 100 early-stage (less than 5 years) technology-based member companies at various stages of development and other interested parties to make up the Connect network.

In focusing on Connect Scotland, the paper will address some identified gaps in current knowledge regarding regional enterprise support networks, namely: establishing why and how private-public agents are involved with the network, establishing levels of interaction among agents; and evaluating the benefits or ‘value’ derived by agents from their network participation. These multi-stakeholder benefits are evaluated over a two-year period to assess possible changes to social, knowledge and financial benefits that are explicit objectives of the Connect program. Establishing other notable factors contributing to the building of the support network is a further objective of the paper.

2.0 Enterprise Support Networks

The concept of enterprise support networks is based on entrepreneurial network theory that suggests strength, complexity and diversity of business relationships influence start-up performance that can result in longer-term chances of firm survival and growth (Shahidi 1998). Network theory includes contributions from research showing that entrepreneurs gain access to resources and knowledge through their personal networks to start-up, develop and grow enterprises (e.g. Birley 1985; Starr and Macmillan 1991; Dubini and Aldrich 1991; Hansen 1995; Johannisson 1995).

In addition to resources and knowledge provision, networks are seen to provide social support, self-confidence and strategic capacity for entrepreneurs to organise for new activities (Johannisson 1995). Starr and MacMillan (1991) argue that entrepreneurs need to mobilise 'social resources' due to liabilities that include size, lack of market legitimacy and newness. Similarly, Sharman *et al* (1991) found that networks contribute positively to gaining organisational legitimacy and to developing a desirable marketplace reputation.

Research literature also stresses the importance of informal social contact as a starting point to knowledge acquisition for entrepreneurs. Initial contacts from social networks evolve into business-focused networks, and then into strategic networks, which allow firms to innovate and to thrive by their links to other organisations (Falemo 1989; Dubini and Aldrich 1991; Butler and Hansen 1991; Aldrich and Zimmer 1986).

Network creation is suggested as a growing policy prescription for regions where networks have failed to emerge (Malechi and Todtling 1995). Justification for creating networks is based on the resource-based view of enterprise (e.g. Penrose, 1959; Teece, 1996) and research on clusters and regions (Saxenian, 1994; Nelson, 1998) that suggests that innovation, growth and competitiveness for enterprises are optimised when enterprises are able to identify and utilise 'knowledge-based assets' defined as 'competencies, skills, routines and capabilities. These assets are often exclusive to the enterprise and the clusters or regions in which they operate. Conversely, research on regional clusters by Almeida and Kogut (1997) reveals

inconclusive evidence that new enterprises are more successful when located in clusters. They claim that only when there is sufficient technological opportunity do benefits of clustering outweigh the costs and note that a dense population of enterprises have greater rivalry for resources and will co-operate less.

In the UK context, research cited by Scottish Enterprise (1993, 1996) compared high-technology new ventures in Massachusetts and Scotland and found that in Scotland, there was little networking between industry and research staff in academia and government laboratories, and that informal networks, mutual support and encouragement were low. Other Scottish-focused studies have found a lack of venture capital and inadequate mechanisms for investing in small firms, a shortage of small firm management expertise in strategic high-technology sectors, a lack of interaction and common purpose between academia and industry, and a weak 'entrepreneurial culture' (Collinson, 2000, Danson, 1996, Reid, 1997, Scottish Enterprise 1999). The identified need for a 'critical mass' of particular knowledge and expertise in Scotland has provided justification for Connect and will be further discussed in section 3.0.

2.1 Evaluating Enterprise Support Networks

Literature suggests a number of methodological difficulties for evaluators of enterprise support networks. These difficulties include the primarily social or informal character of many networks (Johannisson 2000) and difficulties in tracking how local supportive mechanisms allow new firms to assemble resources and capabilities (Malecki 1997). Another issue is the potential need for a longer evaluation time frame to identify network effects on enterprises. Segal *et al* (1990) in their evaluation of the Cambridge (UK) phenomenon, argue that it takes a long time to build technology businesses. A related view is provided by Smallbone and North (1996) who argue that it is necessary to take a long-term view to benefits gained by new ventures which recognises that the economic impacts of new ventures may change as firms start-up and evolve in their critical early years.

Determining cause and affect attribution contributes to difficulties in evaluating program 'value for money' and assessment of impact, common features of *public*

program evaluation (Rossi *et al* 1979). A related problem for evaluators is that various measurements of program 'success', i.e., job creation, company growth or survival rates, may not be identified as program objectives or may be inadequate to capture actual program effects (Gregory and Martin 1998).

The intent of this paper is to explore 1) the evolution of the enterprise support network - the roles of private-public agents and network-building activities of Connect; and 2) the multi-stakeholder benefits from the network - rather than impact on new enterprises per se. Most promising for this intent is literature on *process* evaluations (Rossi *et al* 1979; Patton 1987; Gregory and Martin 1996). Process evaluations include the following criteria: 1) defining the original intent of a program for all stakeholders and a description of program activities; 2) identifying growth or change throughout the program; and 3) including a full range of stakeholder perspectives if evaluation results are to gain widespread acceptance and credibility in the public domain.

Guided by process evaluation criteria, the methodology used for the paper includes an assessment of the Connect program, analysis of growth and attendance data, results from stakeholder interviews and two survey questionnaires (1999 and 2001) to determine perceived value by stakeholders from Connect activities and how this value may be changing over time.

3.0 Connect Scotland

Since its inception in 1996, Connect has maintained the following mission: "*To support the creation, development and growth of technology-based enterprise throughout Scotland*". Connect's national focus requires that it bring together multiple actors in different regions of Scotland that include universities, sponsors, entrepreneurs and companies. Connect's mission above follows the rationale that interaction between these private-public communities is critical for the development of high growth and high technology enterprises.

The Connect concept conforms to one of the key themes in the Scottish Higher Education Funding Council's (SHEFC)¹ Corporate Plan, namely, "to develop the responsiveness and vitality of the research base in Scottish higher education, and to work with higher education institutions and other agencies in contributing to economic competitiveness and the quality of life." More specifically it conforms to a critical objective within this theme, "to develop further links between Scottish higher education institutions and industry and commerce."²

A wide range of factors requiring attention to help nurture a technology ventures culture and economy in Scotland was identified in the SHEFC document that was built on the earlier Commercialisation Enquiry conducted by Scottish Enterprise (SE) and the Royal Society of Edinburgh (RSE). Strategies to tackle the problem were proposed, amongst them, the establishment of "a networking and business support infrastructure to generate effective academic-industry links facilitating the multi-directional flow of information between academia, companies and service providers".

Creating a supportive environment for technology-based enterprises in Scotland is not perceived as a short-term endeavour. As the Commercialisation Enquiry document, *Technology Ventures: Commercialising Scotland's Science and Technology*, made clear, there are multiple challenges and these must be faced through a variety of initiatives ideally involving all key stakeholders³.

3.1 Private-Public Stakeholders and Expected Benefits

The Connect program targets involvement of identified private and public stakeholders, who are expected to realise benefits from participation described below.

¹ MacDonald, I., *Connect – The University of Edinburgh Programme in Technology and Entrepreneurship*, 29 May 1996. Proposal to SHEFC detailing the Background, Mission Statement, Key Stakeholders, Programme Administration and Activities, Resource Requirements and Funding.

² Request for Funding from SHEFC to Support the National Development of the Connect Programme (1997).

³ Royal Society of Edinburgh/Scottish Enterprise "Technology Ventures: Commercialising Scotland's Science and Technology". Glasgow: Scottish Enterprise (1996).

Universities and Research Institutions

- ◆ Scottish science base will benefit from facilitation and support for technology transfer to new and existing firms, by spin-out or through collaborative projects;
- ◆ Individual academics and researchers will benefit from an effective infrastructure which institutions can use to better understand the needs of technology-based companies and financial sectors and to commercialise their research;

Technology Companies⁴

Technology companies will benefit from an enhancement in their ability to:

- ◆ access new markets, clients, partners, products, technology and finance, and their general marketing skills; including access to technical and managerial assistance;
- ◆ secure developmental/growth funding; and stimulate collaborative projects between technology businesses and universities/research centres;
- ◆ facilitate creation of spin-out companies from the Scottish science base;
- ◆ learn about business development and issues germane to their industries; and benefit from the development of an expert infrastructure that understands and supports, and benefits from, the needs for success in the global market.

Service Providers (e.g. attorneys, bankers, accountants, marketing professionals)

- ◆ Service providers will benefit from enhanced competence regarding high technology products, companies and industries. This happens through the provision of technical briefings and education about unique characteristics of high-technology products, financing, manufacturing and marketing.

General Community and Complementary Initiatives

- ◆ The general community is expected to benefit from increased community awareness of the issues affecting the development of high technology enterprises, as well as from the provision of a community resource for data and information on the status of research activities and business development in high-technology;
- ◆ Complementary initiatives (support agencies and programs) will benefit from the provision of a resource that can be used by all participants.

⁴ These are defined by Scottish Enterprise/Connect as companies competing on the basis of proprietary technology or know-how.

3.2 Description of Connect’s Activities

Connect’s mission and objectives are to be achieved through a program of activities and events facilitating and encouraging interactions between a wide variety of communities, including entrepreneurs, technologists, scientists, banks, equity capital providers, business consultants, accountants, lawyers and policy-makers, helping to bridge the knowledge gap existing between these communities. To achieve its aims Connect has designed an evolving program of 6 events (Table 1).

Table 1: Connect’s Events

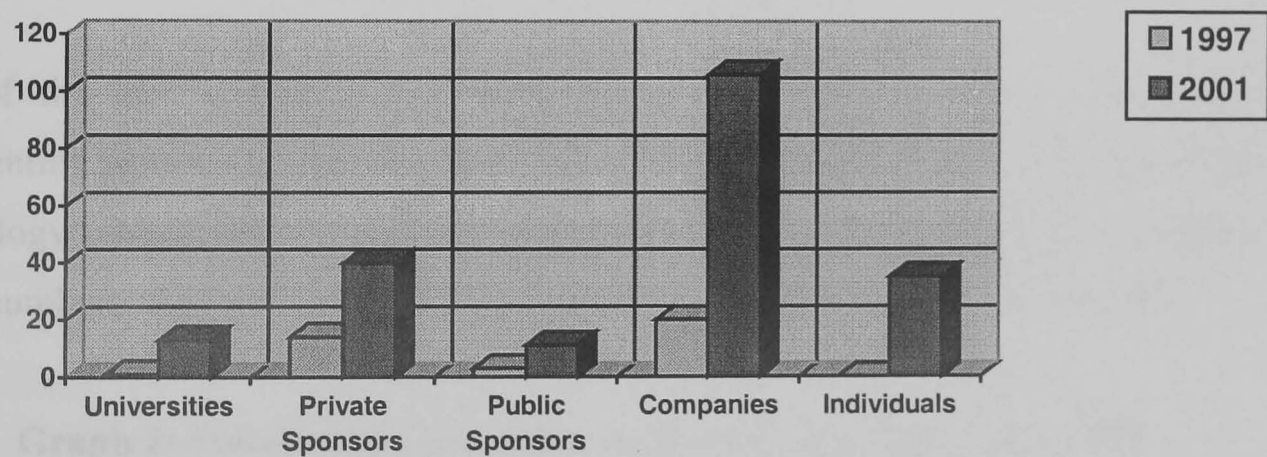
Type of Event	Description	Objective
Technology briefings	Forum for institutional researchers to present their work and research activities to Connect sponsors and tech companies.	To enhance understanding and facilitate technology transfer
Enterprise Workshops	Workshops bringing together technology companies and researchers with advisors and business professionals	To develop general mgmt. skills of both technological entrepreneurs and entrepreneurial technologists
Meet the Entrepreneur	Technology entrepreneurs discuss the development of their businesses, their successes and failures and their views of what it takes to succeed.	Learning from the experience of others and discussing development of their own businesses
Investment Conference	Annual venture capital investment conference.	To provide the opportunity for technology companies seeking finance to present to audience of international investors
Springboard	Forum for individual/businesses to present, in confidence, their technological concepts, proposed business strategy or business plans to an expert panel.	To provide the entrepreneur or academic with practical, realistic and expert advice and recommendations
Bootcamp	Two-day course providing preparation for the investment conference.	To provide a series of experts to discuss core subjects

Each event in Table 1 is expected to play a specific purpose for specific target audiences and they combine to fulfil the targets of the overall program. Three recurring types of events are central to Connect’s national constituency mandate: *technology briefings, enterprise workshops and meet the entrepreneur* events. This is because the majority of the Connect constituency come together at these three events, delivered primarily at four locations: Aberdeen, Dundee, Edinburgh and Glasgow.

4.0 Discussion and Results

A key objective of the Connect programme is to develop a national supportive network or infrastructure for new technology-based companies in Scotland. Graph 1 shows the growth of the network from 1997 to June 2001. Overall, the size of the Connect constituency has grown to 169 organisations (63 sponsors and 106 member companies) and 35 individual members. The significant five-fold increase in ‘subscriber’ stakeholders of Connect since 1997 seems to suggest that the Connect program is delivering benefits to each category. The level of renewals among sponsors, in particular, is almost 100%. Sponsors contribute funding - £3000 fee per year - while members are companies and individuals paying a small fee of £100 per year in exchange for receipt of newsletter and the opportunity to present their ideas at the Springboard event and Investment Conference. The theme of Connect’s value to stakeholders will be dealt with in greater detail in section 4.2.

Graph 1: Stakeholder Growth over 5 Years (1997-June 2001)



In assessing the growth of the Connect constituency, it was found that a critical mass of both private and public sponsors was secured following two key milestones in Connect’s early evolution. The original challenge for Connect back in 1997, according to CEO Ian MacDonald, was to get people in Edinburgh to sign up to a program based on the premise that “we are going to do something which is useful, will you pay for it”? Awareness of Connect as a program and brand was non-existent and initial credibility was provided by the addition of Martin Ritchie as Connect’s Chairman. One of Scotland’s most successful and visible entrepreneurs, Ritchie also provided Connect with management and leadership capabilities and access to a far-reaching business network. MacDonald affirms that Ritchie was key in establishing a

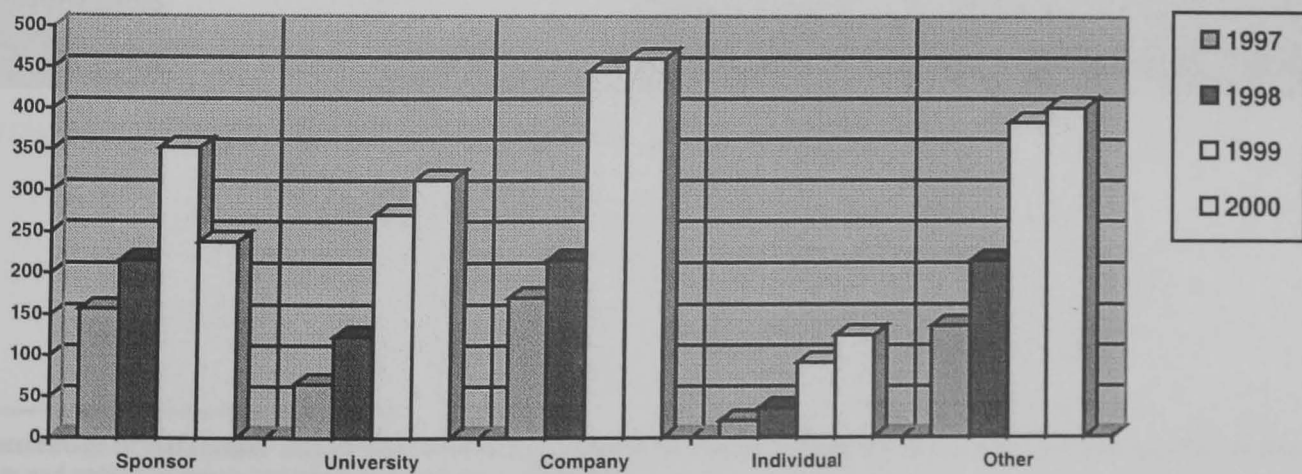
core of 20 founding private sponsors and dealing with numerous public and private organisations to promote the concept of Connect.

Secondly, Scotland's leading research-led universities (Edinburgh, Glasgow, Strathclyde and Heriott-Watt) signed up early as Connect sponsors, thus 'pulling' the other Scottish universities into the network quite quickly. It may be that other universities did not want to miss out on commercialisation activities and opportunities for their technologies, and the establishment of a Connect network with a base of Scotland's top universities as public sponsors offered appeal to the remaining universities to join the network. Although universities represent the largest single 'homogenous' category of sponsors, professional services (e.g. accounting, law and financial) comprise the majority of the private sector companies. Private sponsors are primarily Edinburgh and Glasgow-based or along the central Scottish belt where the majority of businesses are located.

4.1 Mix of Stakeholders and Attendance at Connect Events

One of the key objectives for Connect is ensuring the 'mix' of stakeholders representing private and public supportive agents, the universities, entrepreneurs and technology companies. Graph 2 illustrates the evolution of stakeholder attendance (total numbers of people by category) to recurrent events between 1997 and 2000.

Graph 2: Stakeholder Attendance to Recurrent Events, 1997-2000



Graph 2 shows significant growth in all stakeholder attendance during this period, but growth was especially high for all stakeholder categories between 1998 and 1999.

This reflects the fact that, during this time, Connect began developing the national constituency in Scotland from its base in Edinburgh.

Table 2 provides percentage participation by stakeholder against targets set by Connect for their first 4 years⁵. The percentage of university attendees is increasing slowly but below the 4-year target while that of technology companies is stable over this time period. The attendance objective of technology companies and business professionals has been achieved, although it can be seen that the percentage of business professionals in attendance is declining. Monitoring this mix of stakeholders to recurrent events is an important activity for Connect in achieving the value exchange between and among network stakeholders that contribute to Connect's overall program objectives. Stakeholder value will be discussed in the next section.

Table 2: Connect's Event Targets and Achievements 1997-2000
(Percentage of Attendees to Recurrent Events by Each Stakeholder Category)

Category	4-Year Target	4-Year Achievement	2000	1999	1998	1997
% Universities	30%	16.25%	20%	18%	15%	12%
% Technology Companies	50%	29.25%	30%	29%	27%	31%
% Business professionals	20%	23.5% (sponsors)	15% (sponsors)	23% (sponsors)	27% (sponsors)	29% (spons)
% Individuals		5.25	9%	5%	4%	3%
% Others		25.75	26%	25%	27%	25%
% Companies ⁶ , Indivs., Others		60.25%	65%	59%	58%	59%

⁵ The 'percentage of stakeholder' targets were created by Connect CEO Ian MacDonald to ensure that there was an effective mix of private and public sponsors, entrepreneurs and new enterprises.

⁶ There is a difference between the target categories (universities, technology companies and business professionals) with the categories used for attendance at the real events (sponsors, universities, technology companies, individuals and others). For comparative purposes, the discussion that follows equates "business professionals" with "sponsors" and "technology companies" is also assumed to include "individuals" and "others."

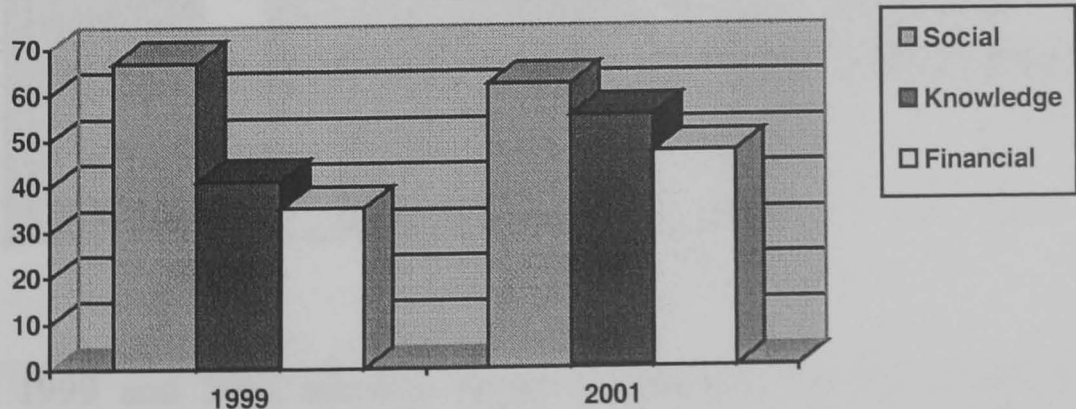
4.2 Value Perceptions by Private-Public Stakeholders

As described in section 3.1, specific benefits to private-public stakeholders contribute to meeting Connect’s overall program objectives. In order to establish common expectations of all stakeholders, three value flows were identified from Connect’s own event objectives -social, knowledge and financial value flows (see Table 1). Knowledge value is an overriding expectation of all Connect events, with financial value also pursued – although more explicitly with the investment events. At the same time, social value is central to Connect’s mandate since informal and formal social contacts are the starting point for business-focused networks and developments. Each of the three value flows was decomposed into a series of topics aimed at capturing a gradation of impact or value added by Connect as perceived by the program’s stakeholders. Resulting topics provide the basis for questions to stakeholders on where Connect has been beneficial regarding social and business contacts, gaining or giving relevant knowledge and attracting or providing financing.

Two value surveys were conducted, the first in 1999 and the second in 2001, that establishes how *different* private and public sponsors and member companies and individuals assess the value of Connect at two different points in time (using a modified Lickert scale). A total of 113 active attendees to Connect’s recurrent events completed the survey and responded to open-ended questions on Connect’s benefits.

Graph 3 shows that, from both the 1999 (n=69) and 2001 (n=44) surveys, social value is rated as the most important perceived benefit from attendance to Connect events.

Graph 3: Perceived Value (%) from Attendance to Connect Events (n=113)



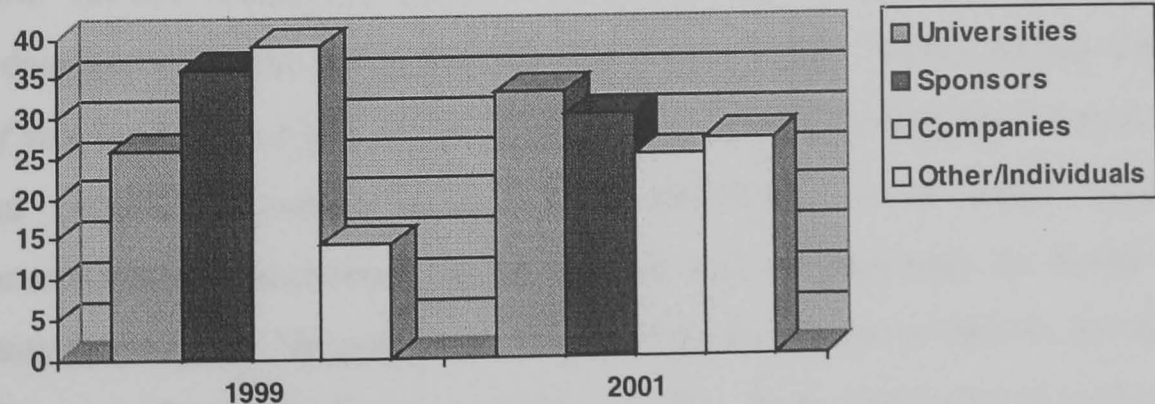
The high rating of Connect as a social network is consistent with the logical evolution of networks where social interactions and acquaintances tend to precede the exchanges and collaborations involving knowledge and financial value.

Graph 3 shows an upward shift in perceived financial and knowledge value, with a downward shift in perceived social value in comparing the 2001 survey results to 1999. The difference in perceived value between social value and knowledge and financial value has reduced significantly, suggesting that Connect is perceived as delivering more substantial knowledge and particularly financial value. The shift in value suggests that social networks have become more established and are perceived as less important. Established social ties provide the atmosphere of credibility and trust that are considered prerequisites for knowledge sharing and development of business relationships that include investment. Indeed, research has stressed the importance of informal social contact that evolve into business-focused networks, and then into strategic networks.

Stakeholder Social Value

A better picture of this change is observed when perceived value is analysed according to stakeholder categories. Graph 4 shows perceived social value has risen in university and individual categories and dropped in sponsor and company categories between 1999 and 2001.

Graph 4: Perceived Social Value (%) by Stakeholder Group (n=113)



Over the 1999 and 2001 surveys, sponsors describe Connect as an inexpensive network that creates good dialogue for support. Networking is considered critical for

sponsors because key and important people are at these events; and entrepreneurs as well as sponsor have the opportunity to draw on others' experiences. Related comments from sponsors include: 1) *"We view Connect as an opportunity to meet others (advisors and companies etc.) working in the technology sector. It is a very useful networking forum, with a particularly relaxed manner"*; 2) *"We expect to raise our company profile in the technology sector by being active contributors in helping Connect reach its goals locally"*.

All Scottish universities are sponsors of Connect and there is an expectation that social contacts can and will lead to collaboration. As one respondent put it: *"Good networking is pivotal."* Another respondent stated: *"We want to see a vigorous market in technology-based industries in Scotland. We expected Connect to play a significant part in support this market by bringing together relevant communities. These expectations have been met to some extent"*.

University respondents rated social value actually higher in the 2001 survey, with a general perception given that Connect provides access to an informed network of key supporters of high technology in Scotland. As one university respondent stated: *"Networking is the start of everything, that includes the build-up of friendship and trust"*, echoing the importance that other stakeholders place on creating social relations for new participants initially upon entering the network.

Another common response from universities was the access to an informed network. Three universities alluded to their need to keep in touch with what is happening in Scotland. As one respondent stated: *"[Our] university needs to be there"*. Another respondent noted Connect as a valuable resource, stating: *"[One] knows Connect is there if you need it, as it is a group of people within a supportive environment"*. As a national program, Connect seems to be delivering social value beyond the conglomeration of universities in the central belt of Scotland, as noted by one university who stated: *"In general, Connect provides a good service in Aberdeen. It provides a good meeting forum and helps to link those interested in technological innovation and providing services"*.

Compared to the 1999 survey, company respondents in 2001 were more diverse in their perceived social value in attending Connect events. One common theme is the importance of Connect as a venue for initiating and developing social relationships that may lead to business opportunities. The following quotes qualify this expectation: 1) *“Networking is most important for first-time attendees to build relationships; then for keeping in touch and keeping those contacts”*; 2) *“Connect facilitates making and keeping contact in a range of sectors, i.e. academic and public sectors, various industry sectors”*.

Connect is also seen as a venue for actually doing business by some companies who suggest this is due in part to the informal atmosphere that allows for interaction of service providers and companies as potential clients. Connect’s recurrent events provide a social environment that is conducive for business as noted by these three company respondents: 1) *“Connect is well-suited for doing business and facilitates it well; there is no problem flashing business cards at the events and Connects is good at managing these different interests”*; 2) *“Connect is the most relevant network for potential business, because of the overlap of potential clients of [our company] and the Connect attendees”*; 3) *“The networking platform is very important in that it provides a solid mechanism for the biotechnology community to network with other stakeholders”*.

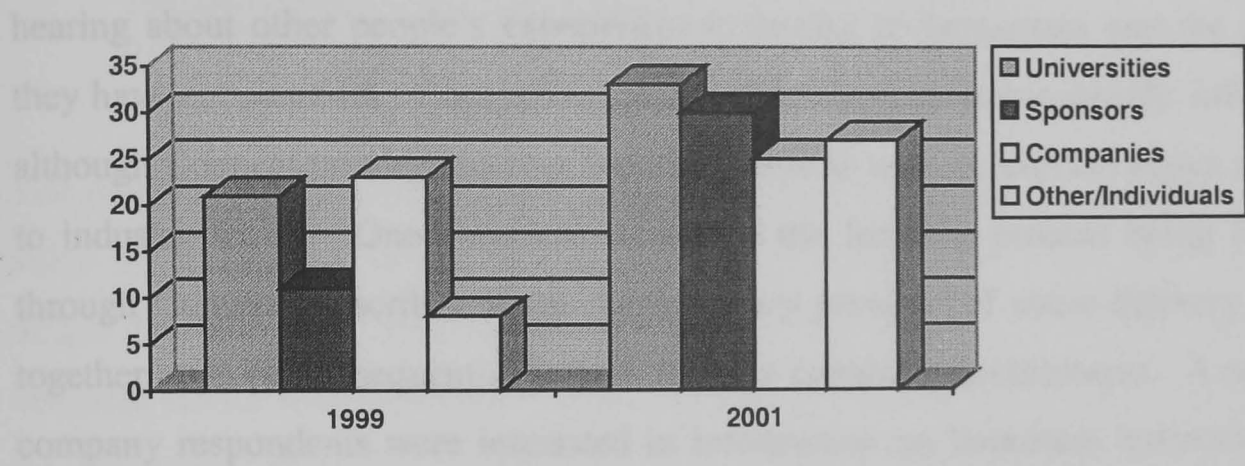
A further social value expressed from company respondents was the importance of Connect as a venue for like-minded entrepreneurs experiencing similar issues and difficulties. Three comments related to these theme are noted: 1) *“Connect reflects a shared vision of everyone of future success of start-ups”*; 2) *“ It is a place to meet different people that share similar experiences...it’s lonely as an entrepreneur”*; 3) *“Our expectations are to continue to have links with other new technology companies”*.

Stakeholder Knowledge Value

Graph 5 shows an upward shift in perceived knowledge value by all stakeholder groups between 1999 and 2001. The difference in perceived value between social value and knowledge and financial value has reduced significantly from the 1999

survey, indicating that Connect is perceived as delivering more substantial knowledge and particularly financial value. Providing as well as obtaining knowledge is a strong theme among companies and sponsors, but not universities, reinforcing the findings that knowledge sharing between university and business remains low at events.

Graph 5: Perceived Knowledge Value (%) by Stakeholder Group (n=113)



There are two themes to sponsor comments on the perceived knowledge value of Connect. The first is the use of Connect as a training venue for staff, as noted by one sponsor: *“Connect allows us to expose staff to industry sectors to increase their knowledge; with the intention of eventually giving sector advice to clients”*.

The second theme for sponsors is the role of Connect as an ongoing knowledge provider, with Connect facilitating, as one sponsor said, the *“lateral transfer of information”*. Two similar comments are noted: 1) *“[Connect] breaks down the lack of knowledge; a key problem in Scotland”*; 2) *“[Connect allows for] market awareness, who are the players, angels, etc. and what is innovative in Scotland”*.

University respondents commented on the importance of knowledge on what others were doing rather than the provision of knowledge on commercialisation topics per se (it is important to point out that university respondents were overwhelmingly technology transfer or commercialisation staff; scientist/entrepreneurs would more likely be members). One respondent stated, *“ Connect is important for gaining insight into how others are tackling issues of commercialisation; such as where are the gaps? Related comments include: 1) “Connect assists in the process of making the decision of doing something alone or within the university”; 2) “Connect facilitates a greater awareness of closed institutions...with Technology Briefings, one*

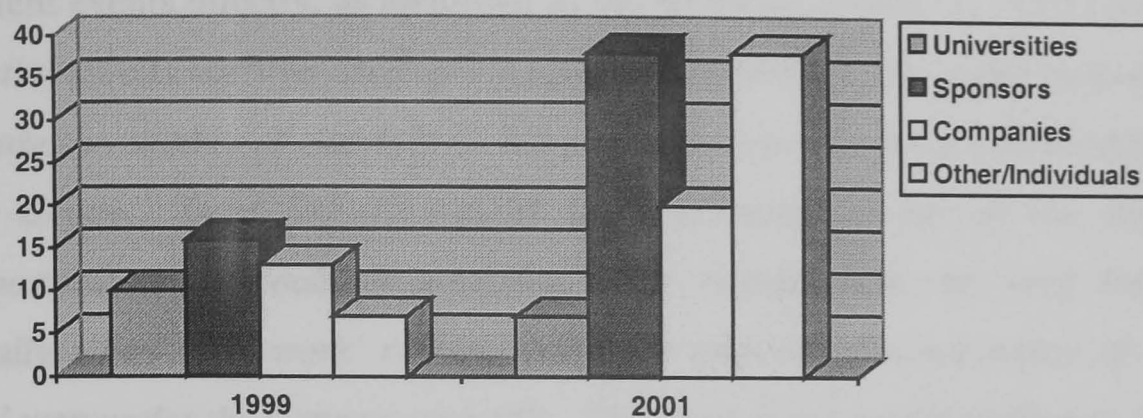
can get a snap-shot of a technology or industry sector in a single session”; 3) “Knowledge through events is realised on how to do something; this differs from experience with the civil servant mentality”.

Knowledge value for companies was rated as most important through shared business experiences with other entrepreneurs. Three company respondents noted the value of hearing about other people’s experiences in setting up businesses and the problems they have encountered. Companies are also interested in sector-specific information, although Connect provides a cross-sectoral venue as well as relevant topics according to industry sector. One comment related to the learning process being facilitated through Connect, described as an *‘evolutionary process’* of event delivery that tied together appropriate sequential themes for new company development. A number of company respondents were interested in information on important business services (e.g. *“last year’s seminar on insuring businesses was informative”*). It is interesting to note that companies do not cite university-generated knowledge as highly important. This reinforces the point made earlier that university-business interactions and exchange still require substantial development work.

Stakeholders Financial Value

The perception of financial value in Graph 6 shows clear variations between stakeholder groups, in contrast to social and knowledge value perceptions. It should be pointed out that financial value questions in the survey include receiving and giving financial information as well as providing and receiving investment or new business through the recurrent events. Financial value does not include results of Connect’s three investment events (Table 1) that assist a select number of technology company members in obtaining investment. Investment events have not been included here, since they are annual events that are clearly focused on select stakeholders and specific outcomes. The relationship between investment events and recurrent events can be considered an evolutionary process, where certain technology companies have progressed – facilitated by the network - to a level where they are investor-ready. This analysis is beyond the scope of this paper.

Graph 6: Perceived Financial Value (%) by Stakeholder Group (n=113)



The majority of Connect's private-sector sponsors are service providers that see the value in developing social contacts early with entrepreneurs who may eventually utilise their services. Sponsors, in return for access to potential clients, provide free business advice and important contact facilitation. This philosophy is suggested by the following comments: 1) *"By providing business advice, it is hoped that clients will develop a moral obligation for a long-term relationship with us"*; 2) *"Connect is supportive of new ventures, in line with the focus of [our company], who want to support and provide services for these companies"*.

Two other themes emerge from sponsors' comments on financial value. The first stresses Connect as a shop window into investment opportunities, highlighted by these responses: 1) *"As a sponsor, we would ideally like to get early sight of opportunities, and perceive of Connect as a 'shop window' for early stage opportunities"*; 2) *"Our firm expects to make contacts in the technology sector which will be a catalyst for new business"*.

The second theme touches on Connect as a contributor to investment deals through its recurrent events. Here the main point is that Connect does contribute indirectly, although it is difficult to attribute the precise credit. As one sponsor stated, *"I am interested overall in business development and good investment opportunities. While others are doing some of the things which Connect does and Connect cannot claim credit for all investment following its investment conferences, I do think it has a role to play"*.

Sponsors generally had difficulty in tracking any new business through Connect recurrent events directly, as identified in the following quotes: 1) “[We] want to see potential clients early to develop long-term relationships; our prime motivation is to increase the number of clients”; 2) “Although most new ventures can’t initially afford [us], Connect is a link to get to know potential clients of the future”; 3) “Opportunities to establish potential client relationships are very limited and virtually all of ‘new work’ comes from other sources. I’m not aware of any ‘new work’ won under the Connect umbrella. That said, it is a useful medium to keep up to date with this sector, know what young companies are up to and to tell people what [our company] is doing”.

One potential explanation for an apparent dichotomy between the low level of business deals realised by service providers and their high level of sponsorship renewal is that business deals are not the primary benefit expected from sponsorship. As described, other benefits are being realised by private sponsors from network participation. Another explanation is sponsor acceptance of a longer-term view of benefits, as stated by Connect CEO Ian MacDonald in 1997: “From the outset it was emphasised to sponsors that they would be unlikely to see any significant return on their investment for at least three to five years.”⁷ With Connect now entering its sixth year of operations, securing business deals from the Connect network may begin to take greater precedence for sponsors when considering renewal.

As Graph 6 shows, there is an upward shift in perceived financial value by all stakeholder groups except universities. This is consistent with a challenge identified for Connect, namely that the relationship between universities and other stakeholders can be improved upon. In both 1999 and 2001, university technology transfer respondents were unanimous in stating their expectation to secure investors for their technologies. Interviews with technology transfer staff representing three universities in 1999 found that seeking and securing financial support for university research was a prime motivation for participation in Connect. Related comments include: 1) “[Our] university already has technologies waiting to go”; 2) “Through Connect we

⁷ Request for Funding from SHEFC to Support the National Development of the Connect Programme (1997)

hope to expose enough to secure financial backing for university technologies”; 3) “We want to meet potential funders of our technologies”.

From the 2001 survey, Connect’s financial value for universities has been below their expectations. As one university respondent pointed out, *“I feel that the level of engagement of firstly, academics talking about spin-outs and secondly, real venture capitalists, have been a bit lower than I expected.”* Another university respondent stated, *“What I have not seen much of... in Aberdeen, is the presence of potential investors at the meetings. Investors in technology and new start-ups are few in Aberdeen and even fewer seem to come to Connect meetings”.*

Three university commercialisation officers stated that they had yet to obtain financial backing for ideas/products but expect to in the future. This is further evidence of the fact that Connect still has a great deal to do to break through the challenge of improving significantly university-business interactions that may include a more active role in managing university expectations.

Two themes emerge from companies’ comments regarding financial value. The first relates to indirect financial benefit expectations. As one respondent stated, *“Through membership in Connect, I expect to become part of a network of like-minded business professionals and expose my company to opportunities for partnership and development”.* The second relates to more direct investment expectations. Here one company respondent commented: *“My expectations are that I will meet potential investors and I feel that this has been achieved.”*

Graph 6 also suggests that the individual/other stakeholder category, many of whom represent financial intermediaries and trading companies, are identifying the value they provide regarding financial advice more than the gains from receiving business from new companies at this time. As noted earlier, more direct financial value realised by stakeholders - those technology companies and spin-outs that have presented at Connect’s investment conferences – reflect a more active role of Connect in linking opportunities with investment and has not been included in this study.

5.0 Summary

The aim of this paper has been to describe the building of a private-public enterprise support network in Scotland and address identified gaps in current knowledge regarding enterprise support networks. The Connect network comprises key elements of a regional supportive infrastructure or *constituency* that includes over 50 private sponsors, public 'local enterprise companies' (LECs) of Scottish Enterprise, all 14 of Scotland's universities and over 100 Scottish-based technology company members from a cross-section of sectors. Key identified milestones in building the national network include strong evidence of need for intervention and support, establishing private-sector program credibility by involving a high profile business leader and establishing public sector program credibility from Scottish Enterprise and Scotland's core of leading research universities.

Results from two value surveys in 1999 and 2001 provide evidence that private-public agents are drawn to Connect's activities and contribute to the building of a national enterprise support network by value they expect to derive from participation. Findings suggest that social, knowledge and financial value have evolved over time within the Connect network as perceived by active respondents. Social and knowledge values may be more important in earlier periods and influence opportunities to realise knowledge and financial value at later stages due to factors that include the building of trust, familiarity, learning and the formation of relationships among network constituents.

Benefits being sought within the Connect network are seen to depend on the proper 'mix' of stakeholders that facilitate a level of 'value exchange'. New technology companies and universities indicated their expectation of finding investors, but companies valued knowledge benefits more highly than universities. Private sponsor service providers indicated their expectation in finding business prospects but interestingly, the low level of generated business prospects suggest that other benefits maintain these sponsors' continuing engagement with the network. Introductions by third parties was noted as an important aspect of establishing contacts with investors at events and being introduced to new business prospects. Findings suggest that further effort is needed to link the university environment with the commercial one in

supporting new technology companies. This is a challenge also for Scottish policy makers and other key public and private institutions. Another challenge for Connect as a private-sector driven network is ensuring a balance of altruistic outcomes on behalf of entrepreneurs and new companies on the one hand and business-generating outcomes to private sponsors on the other hand.

The paper has found that Connect acts as a 'co-ordinating mechanism' that facilitates at the national level the interactions that lead to multi-stakeholder value exchange. Although Connect as a program fundamentally 'connects' private-public sponsors with entrepreneurs and technology companies, and stimulates social, financial and knowledge flows, Connect itself does not pursue the formal and systematic mentoring of emerging technology companies. In this respect, Connect has no direct control of processes leading to new or increased numbers of collaborative projects, spin out companies, or new jobs. As mentioned, Connect more directly facilitates processes by which technology ventures and academic spin-outs secure funding through their investment events.

The paper concludes that Connect's success to date in creating a national enterprise support network can be attributed to a combination of multi-stakeholder benefits being realised and Connect's integrated set of network building events and network management activities.

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**Evaluating a Regional Support Network for
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